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THE HUDSON RIVER TUNNEL CO. is reported as having notified railway companies having terminals in New York that the first track of the tunnel will be completed within a few months, and the tunnel company is ready to negotiate with them for bringing trains to New York. Before this can be done however, there is an enormous amount of work to be accomplished in providing proper approaches and connections.

THE NEW HERRESHOFF STEAM YACHT, built for Mr. W. R. HEARST, of San Francisco, made a trial trip lately at the rate of 24 miles per hour under 200 lbs. of steam. She is licensed to carry 200 lbs., and is guaranteed to make 25 miles per hour. The yacht is 112 ft. long, 12.4 ft. beam and 5.4 ft. draught. She has an 800 HP. quadruple expansion engine and tubulous boiler of the Thornycroft type.

THE PLANS FOR THE NEW HARLEM BRIDGE, submitted by Mr. A. P. BOLLER for Seventh Ave., call for a structure 67 ft. wide, with one of the heaviest draw spans in the world. The estimated cost is $1,250,000, the amount appropriated by the Legislature for this work. The draw span will be 415 ft. long, and the pivot is peculiar in having a double set of bearing wheels and an excellent arrangement for distributing the enormous weight. The treatment of the masonry in this bridge is especially artistic.

CRUISER No. 13, the mate to No. 12, or "The Pirate," and a 21-knot ship, is to be built by the Cramps, of Philadelphia, though the Bath Iron Works, of Maine, put in a lower bid. The Secretary of the Navy gives as his reasons for this the fact that the Cramps have alone of all our shipbuilders proved their ability to build ship and engines of the character and dimensions required. The Bath Works acknowledge that they would have to sublet the engines, and could not build the ship in less than 3 years. The Cramps reduce their bid $50,000, and the contract is awarded at $2,690,000.

THE BOSTON RAPID TRANSIT COMMISSION has had $2,500 appropriated by the State for the purpose of defraying a portion of the expenses of commissioners who go abroad to investigate the subject in England and Europe. The Chief Engineer, Mr. GEORGE S. RICE, and Messrs. J. E. FITZGERALD and JAMES B. RICHARDSON are named as those likely to go

THE DRY DOCK at Point Turner, Puget Sound, is to be commenced at once. The engineer of the work will be Mr. THOS. C. MCCOLLOM, M. Am. Soc. C. E. and Civil Engineer U. S. Navy.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear collision on the New York, West Shore & Buffalo R. R. near Port Byron, N. Y., about 2 A. M., Aug. 6. A westbound freight train broke in two and the train was stopped and a flagman sent back, while the front part was pulled on to a sidetrack. A passenger train ran into the rear part of the freight train, consisting of a caboose and 2 empty cars. The engine and several cars were wrecked, and 11 Italian laborers in the smoking-car were killed; about 20 or 30 persons were injured The wreck caught fire from the engine, and the 2 express cars, baggage car, smoking-car, passenger car and one sleeping-car were destroyed. The accident is said to have been partly due to the failure of the flagman to go back in time, according to the rule printed on p. 34 in our issue of July 11, in the account of the Ravenna collision on the New York, Lake Erie & Western R. R. The freight train, however, is said to have been an extra, running ahead of the passenger train, and it is this class of trains which causes so many accidents. A dense fog also prevailed at the time of the accident.

OTHER SERIOUS RAILWAY ACCIDENTS are as follows: A head collision occurred at Champlain, N. Y., on the Ogdensburg & Lake Champlain Ry., on Aug. 5. A mail train on the main track was about to be side tracked to let a special excursion train pass, when the latter came up unexpectedly. Both engines were wrecked, and the first car of the excursion train was telescoped by the rear cars. Four persons were killed and about 10 seriously injured. It is claimed that the brakes of the excursion train would not act, and that the train could not be stopped on account of the grade. A crossing accident occurred on the New York, New Haven & Hartford R. R., Aug. 4, at West Haven, Conn., an express train running into a work train which was crossing the main track. Two freight cars were wrecked and some of the passenger cars damaged, but nobody was seriously injured. The responsibility is placed with the crew of the work train. A singular accident occurred in the Long tunnel of the Southern Pacific R. R., near Ashland, Ore., July 29. A double-header passenger train was in the tunnel, when the coupling between the engine and cars broke, causing a delay of 15 or 20 minutes. The smoke and gas almost overcame the driver and fireman of the head engine, and they started to climb out of the cab, but they were so nearly suffocated that they fell off, the former lying with his arm across the track. When the train was backed out by the rear engine the man's arm was cut off, and he died from loss of blood before he was discovered.

THE ST. MANDE ACCIDENT, on the Paris, Lyons & Mediterranean Ry., of July 29, was rendered more terrible in its effects by fire, and the first dispatches charged the origin of the fire to the explosion of the cylinder of compressed gas used in lighting the train. A cable dispatch to this city from the Paris manager of the Pintsch Co. says: "No gas explosion; fire set by ashbox of engine." This statement accords better with experience in wrecks on our own roads where gas was used for car lighting. No fuller accounts of the wreck and its true cause have been yet received. The latest reports point still toward malicious tampering with the signals by some one unknown.

THE COLLISION at Ravenna, O., on the New York, Lake Erie & Western R. R., July 3, which was mentioned on pp. 23 and 34, has been investigated, and the coroner's verdict delivered as follows, the last clause being practically a recommendation for the adoption of the block system.

The engineer of train 8 was guilty of carelessness in not notifying the conductor of his train that he had work to do on his engine, so that all the crew might have been on the alert for approaching trains. The conductor of train 82 was guilty of gross neglect of duty; First, by registering and leaving Kent in violation of the rules; Second, in not using due care and diligence in controlling the speed of his train when crossing the Cleveland & Pittsburg R. R. crossing at 20 miles an hour in violation of the rules and law, and especially in not ordering his men to apply brakes at Morgan's Curve to assist the engineer in coming into Ravenna with his train under control. The engineer of train 82 was guilty of neglect of duty in not blowing his whistle at Morgan's Curve, as that would have notified those at Ravenna of his coming, and of carelessness in not having his train under control. The watchman at the interlocking station at the Cleveland & Pittsburg R. R. crossing was guilty of gross carelessness in not blocking the freight train when he saw danger was imminent, and thus preventing the collision. Rule 87 of the railway company, which permits a fast freight to follow a passenger train at an interval of five minutes, is dangerous and not in accord with sound judgment and public safety. The company is remiss in duty in not equipping all fast freight trains with air brakes to insure perfect control of heavy trains. An emergency danger signal should be situated at every passenger station, and the person having it in charge should be required to display it in full view whenever a passenger train is detained from any cause beyond its usual allotted time, and no two fast trains should be permitted on the same territory between contiguous stations at the same time.

OIL FUEL is now being used quite extensively in Chicago and Pittsburg. Among other large users, the North Chicago Cable Ry. Co. has been testing oil for two years in two of its power-houses, and has now arranged to fit its entire system for oil fuel. In Chicago, fuel oil costs 54 cts. per barrel as compared with coal at $2 to $3.50 per ton. In Pittsburg, Pa., among the companies using this fuel are: Dilworth, Porter & Co., Oliver & Roberts' Wire Works, Pittsburg Tube Works, U. S. Iron & Tin Plate Co., Allegheny Salt Works, the Du Quesne Traction Co., and lately the city of Pittsburg at the Du Quesne pumping station. In Pittsburg, with oil at 50 cts. per barrel of 42 galls. and coal at 70 to 80 cts. for slack, or $1.10 to $1.25 per ton for best lump, the only economy in the use of oil lies in the dispensing with the services of coal heavers and in the saving of the boilers and the avoidance of dust and cinders. In other words, oil reduces running expenses.

THE TRANSATLANTIC RECORD has again been lowered, and the new steamer *Majestic*, of the White Star line, now stands in the place so long held by the *City of Paris*. The *Majestic* sailed from Queenstown harbor at 2.12 P. M., July 30, with 1,366 passengers on board, and made the run to Sandy Hook Lightship in 5 d. 18 h. 8 min. The *City of Paris'* record in August, 1889, was 5 d. 19 h. 18 min. It is fair to say, however, that this record was made over a course longer by 11 knots than that taken by the *Majestic*; had the shorter course been run, at the same average speed, the record would have been within a half hour of that just made by the *Majestic*. The records of daily runs for the two ships are as follows:

City of Paris.		*Majestic.*	
1889.	Knots.	1891.	Knots.
Aug 23.....	432	July 31.....	470
" 24.....	493	Aug. 1.....	501
" 25.....	502	" 2.....	497
" 26.....	506	" 3.....	501
" 27.....	509	" 4.....	491
" 28.....	346	" 5.....	317
Total.....	2,788	Total.....	2,777

In the run just completed the *Majestic* was favored by light winds and smooth seas on all but one day of the voyage. A slight accident to the starboard engine on Aug. 4 necessitated its stoppage for about an hour. The port engine was kept in motion and the total time lost was not over 20 minutes. Other fast records are the disputed record of the *Teutonic* of Aug. 13, 1890, or 5 days 19h. 5m. The *Furst Bismarck*, arriving May 16, 1891, made the run from Southampton in 6 days 14h. 15m., equivalent to 5 days 22h. 54m. from Queenstown.

THE CONTRACT FOR GREAT GUNS, which has been engaging the attention of the Board of Ordnance and Fortifications since July 13, will probably be awarded to the Bethlehem Iron Works, though nothing official has been made public except the decision to award the contract to one of three competing private firms. The delay has been due to the discussion of the bearing of the Government gun factory at Watervliet upon the question of what were "the best interests of the United States" in this matter.

The New Water Supply of Newark, N. J.

(Continued from page 97).

THE STORAGE RESERVOIRS.

As stated last week, the new water supply for Newark, N. J., will be from the headquarters of the Pequannock River, where water will be stored in two large reservoirs called the Oak Ridge and the Clinton reservoirs respectively.

The Oak Ridge reservoir is on the Pequannock River, about 10 miles from its source. The Clinton reservoir is on a tributary of the Pequannock called Mossman's Brook, which joins the river at Newfoundland, about 3¼ miles below the Oak Ridge reservoir. The Macopin intake reservoir, at the head of the pipe line described last week, is on the Pequannock River, about four miles below the Clinton reservoir. Water will flow from the two storage reservoirs to the intake reservoir in the natural beds of the streams. The location of the reservoirs and of the other parts of the system was shown by a map in ENGINEERING NEWS for Oct. 11, 1890.

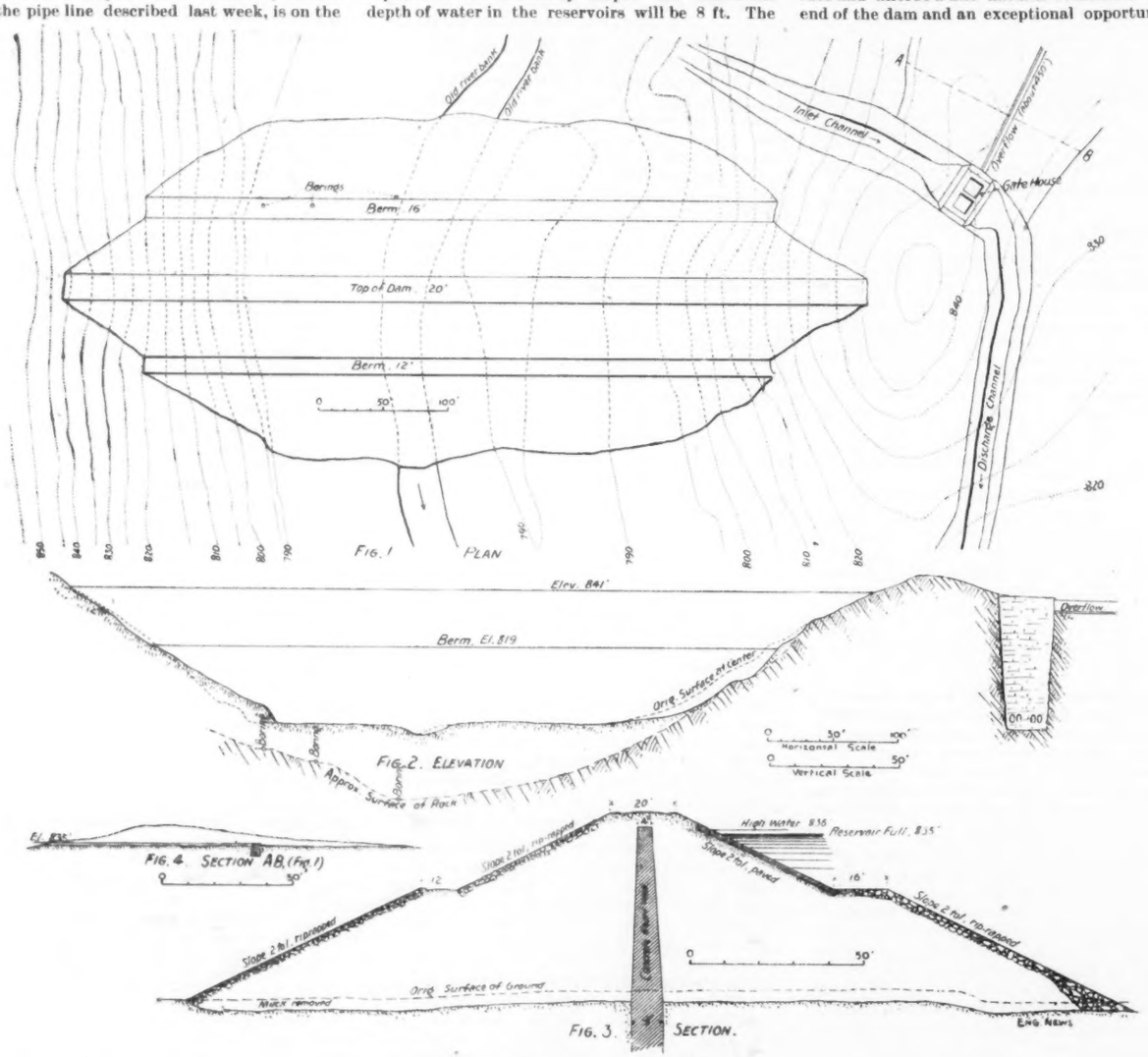
For convenience the following information regarding the elevation, area, capacity, drainage area and daily yield of the three reservoirs is quoted, with corrections, from the issue named above:

Reservoirs.	Elevation above mean tide, ft.	Area in acres.	Estimated storage capacity, galls.	Drainage area, square miles.	Estimated daily yield, galls.
Oak Ridge.	836	700	2,500,000,000	28	22,400,000
Clinton ..	990	400	3,538,000,000	10	8,000,000
Macopin..	890	30	30,000,000	27	21,600,000
Totals ...	.....	1,130	6,068,000,000	65	52,000,000

Each storage reservoir is formed by an earthen dam, with a concrete heart-wall founded on rock. Each has a gatehouse for passing the water to the stream below and on to the intake reservoir and an overflow or spillway at one end of the dam. Each embankment is built of gravelly earth carted on from the adjacent banks of the valley, spread in 9 in. layers, wet from carts or by hose attached to pipe lines, and rolled by corrugated iron rollers weighing 2 tons each. At each reservoir the area flooded has been or will be cleared of trees, bushes, stumps, vegetation, leaves and rubbish. The land has also been cleared for a distance of 60 ft. from the high water line. With the exception of the necessary slopes the minimum depth of water in the reservoirs will be 8 ft. The maximum depth will be about 45 ft. At each reservoir new public roads have been built by the East Jersey Water Co. to take the place of roads previously crossing the reservoir sites, and at the Oak Ridge a road was built on each side of the reservoir. Below the Clinton reservoir an arched masonry bridge of one span of about 18 ft., with roadway 20 ft. above the stream, was built, and at the upper end of the Clinton reservoir a 3-span arched masonry bridge has been built. The new roads are much better than the average road in the vicinity, as the writer can testify after having driven several miles with Mr. HERSCHEL, Engineer and Superintendent of the East Jersey Water Co., on an inspection of the reservoirs.

In this connection it may be stated that a telephone service being necessary in the operation of the completed works, the company has established telephone stations at each of the reservoirs and strung several miles of wire to connect with lines already in operation. The various parts of the work are thus connected with each other and with the Paterson and New York offices. The advantage of such a connection is obvious, especially as an aid to rapid construction.

As has been stated, or intimated, the storage reservoir dams are similar in construction, and as the Oak Ridge dam is now nearly completed and has some novel features a description of it will first be given. A very favorable location was found for this dam at a point where a comparatively short embankment, carried some 50 ft. above the natural surface, would impound about 2,500,000,000 galls. of water. On the east side of the valley rock comes to the surface and affords a fine natural foundation for the end of the dam and an exceptional opportunity for placing the gatehouse in a cut through almost solid rock, in addition providing a fine natural overflow In the center and at the west end of the dam the rock is some distance below the natural surface reaching a depth of from 25 to 28 ft. for a length of 600 ft., or across the main valley.



OAK RIDGE RESERVOIR DAM.

The whole structure is shown by the accompanying illustration. Fig. 1 is a plan of the dam, showing the location of the gate-house, with the inlet and outlet channel, and the overflow, one end of which abuts against the gate-house. Fig. 2 is an elevation of the dam, and shows approximately the relative position of the natural surface and the rock, as well as the gate-house cut and the overflow of the waste-way. Fig. 3 is a cross-section of the dam, and Fig. 4 a section through the overflow on the line *A B*.

The dam is about 620 ft. long, some 280 ft. thick at the base and 20 at the top, and, as shown by the section, 51 ft. above the natural surface. At 29 ft. above the natural surface there is a

berm 12 ft. wide on the outer, and another, 16 ft. wide, on the inner side. The concrete heart-wall is 9 ft. thick from its rock foundation to the line of excavation, for the removal of muck beneath the dam and tapers to 4 ft. in thickness at its top, which is 4 ft. below the top of the embankment. The concrete consists of 3 parts sand, 1 of "Improved Union" cement, a mixture of Portland and natural cement, and 4 parts broken stone. Boulders up to 2½ or 3 ft. in diameter are embedded in the wall. The wall is formed between plank sheeting, as shown in Figs. 5 and 6, the former showing the trenching and bracing at the west end of the dam.

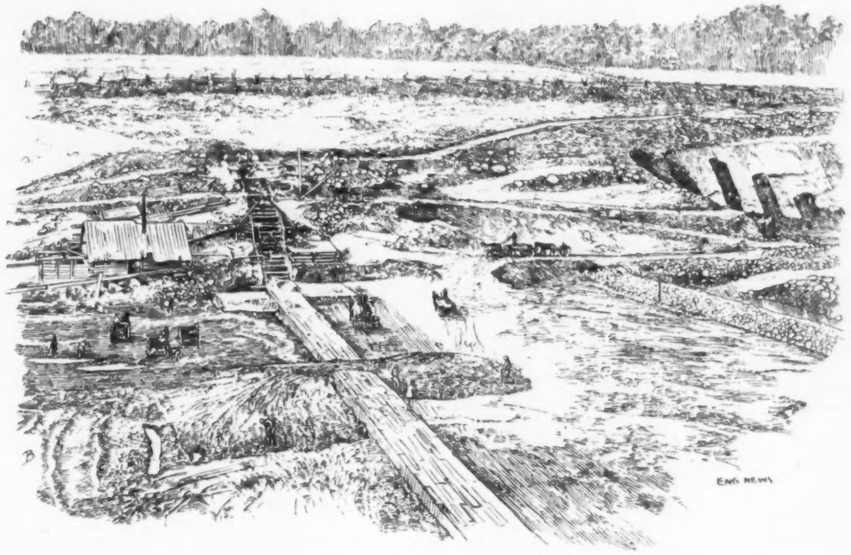


Fig. 5. Oak Ridge Reservoir Dam.

Heart wall is shown running back from center of view; and upstream toe appears in extreme right.

Both slopes of the dam will be covered with stone from the excavation of the inlet and outlet channel, and with boulders found in moving material for the embankment. This stone is adjusted somewhat by hand on the outer slope, and more carefully laid on the inner slope. As originally designed it was not proposed to cover the outer slope with stone, but boulders were so plentifully found in the borrow pits that, being near at hand, the easiest way to be rid of them was to place them on the embankment. Added to the material from the rock excavation stone has been so plentiful, at both dams, as to provide thick coverings for the embankments.

In addition to the above the necessity for sodding, except on the outer berm, is obviated.

The interstices between the stone are filled by throwing gravel upon the slope, as is shown by the part of the embankment below the berm in Fig. 6.

As has been stated, the gate-house is at one end, the east, of the dam, in a channel cut in the rock down to the level of the water surface. The plan, Fig. 1, and the view of the gatehouse, under construction, Fig. 7, together with the view of the inlet channel in Fig. 6, give a good general idea of the structure and the character of the excavation. Except for the gate-house the channel will remain as left by the excavation, the rock being so solid that leaks are not feared.

The gate-house is of masonry, the lower portion being faced with stone having cut beds and joints and the interior of the chambers being lined with brick. Fig. 7 (see next page) shows the structure with the walls carried to within some 6 to 7 ft. of the top, the projection at the front being at about its full height, but its top yet to be covered with cement mortar. The main wall is shown plastered with cement mortar. A day or two after this view was taken a facing of rough stone, in mortar, was being carried up this wall, and this facing was also being covered with cement mortar, to prevent all possibility of leakage.

Iron stairways will give access to the bottom of the two chambers, where four 36-in. gates, two in each chamber, will be used to control the flow of water from the reservoir to the stream and the intake reservoir below. The pipe leading to and from the 36-in. gates is 42 ins. in diameter at its outer end, with reducers connecting it with the gates, thus making use of the Venturi principle (see ENGINEERING NEWS, Vol. XVIII., p. 461), and saving expense by using a smaller gate than would otherwise be required. The gates will be operated from inside the gate-house.

The overflow is shown in section by Fig. 4, and in plan by Fig. 1, at the right. The overflow is about 450 ft. long, of masonry, about 3 ft. wide at the top, 4 ft. at the bottom, and 5 ft. high. It is on the ledge of rock which outcrops here and abuts against the gatehouse.

At the time of the writer's visit to the Oak Ridge dam, July 24, the structure was well advanced, and its completion is expected in a few weeks. Fig. 6 is a view of the dam taken a day or two before the date just named. The point of view is the upper side of the dam at the west end. Fig. 5 is a view of same dam soon after work was begun on the embankment and was taken from the east end, looking diagonally across the dam to its upper side. In Fig. 5 the borrow pits are shown at the right. The heart-wall has been completed from its rock foundation to above the natural surface, and the first layers of earth have been put in place at the right of the heart-wall. At this stage the concrete was, evidently, mixed close by the heart-wall, as shown at the farther end, but later it was mixed in the building at the end of the dam, shown in Fig. 6, and carted to the trench. The engine to drive the stone crusher is located in this building, and farther on is the water tank, to which water was for a time pumped, to be piped to the embankment for use in wetting the material used in its construction.

At the left of the farther end of the dam may be seen the inlet channel. The position of the gate-house is shown by the derrick and ladder.

While the Oak Ridge dam is but some 625 ft. long, the Clinton dam has a length of about 1,500 ft. This dam is about the same height as the Oak Ridge, and in its general design is similar. It differs, however in being curved to obtain a better foundation, with its convex side up-stream, and in having its gate house in the dam, with a covered archway extending each way, an inlet and outlet, and in having a spillway of considable length at the other or east end. Covered channels leading to and from the gate-house might have been built at Oak Ridge; but construction was started there first, and it was thought that the stone from the excavation would be needed for paving the inner slope.

The arangement of gates at Clinton is similar to that at Oak Ridge. The inlet and outlet to this gate-house are formed, as stated, by arched culverts, abutting on the ledge cut, at irregular heights, some 15 ft. wide, the culverts being built of ashlar stone masonry.

At this dam advantage is taken of a side hill to prepare the concrete, the stone being crushed on an upper platform, the materials put together on a second and lower platform, from which it passes to a mixing machine and is discharged on a third level, to be shoveled into carts on the ground below.

At the time of the writer's visit to this dam dirt was being loosened from the banks of the borrow pits by means of powder placed in the holes from 10 to 18 ft. deep, the holes being refilled and tamped with earth. At night, after other work had been stopped, several charges were fired. The foreman in charge thought that but very little, if any, saving was being effected, but that the work was thus made more agreeable to the laborers. It is expected that this dam will be finished before next December.

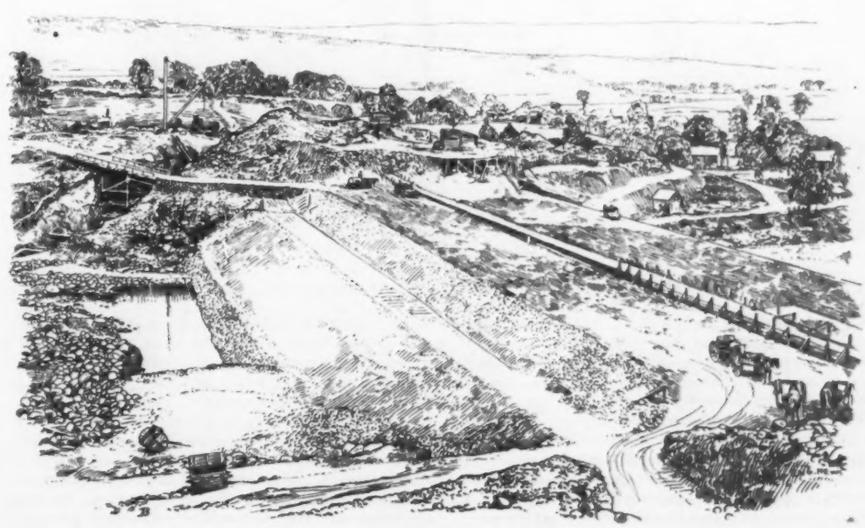


Fig. 6. Oak Ridge Dam; Nearly Completed.

To be continued.)

Electric Mining Machinery.

At a late meeting of the Institution of Civil Engineers Messrs. LLEWELYN B. ATKINSON and CLAUDE W. ATKINSON, Associate Members of the Institution, read a most interesting paper upon "Electric Mining Machinery, with special reference to the application of electricity to coal-cutting, pumping and rock drilling," a paper deduced from four years' experience in applying this class of machinery to mines and in experiments connected with the difficulties to be encountered. An abstract of the salient features of this paper follows.

The principal uses to which electrical power can be applied in mines are—the driving of pumps, of hauling and underground machinery, of coal-cutting machines, drilling machines, and in certain cases fans for subsidiary ventilating purposes. In referring to compressed air and the utilization of the exhaust as an assistance to ventilation, the authors think this is the most costly form of ventilation that can be devised in its expenditure of power. To use compressed air economically, with least bulk of machinery and pipes, it is necessary to work at as high a pressure as feasible. But this increase of pressure, economical and more efficient in the use of steam, reduces the efficiency with compressed air. This is shown by the experiments of Messrs. J. Fowler & Co., at Leeds, who give the following table as to the gross efficiency of compressed air in the transmission of power:

$$\text{Efficiency} = \frac{\text{Brake HP. of motor.}}{\text{I. HP. of compressing engine.}}$$

Air pressure, lbs.	Efficiency per cent.
40.0	25.8
34.0	27.1
28.5	28.5
24.0	34.9
19.0	45.8

These results are borne out by the recent experiments of Prof. A. B. W. KENNEDY on the transmission of power by compressed air, in Paris, on the so-called Popp system. These experiments showed that the brake HP. of the motor (10 HP.) is 31% of that of the engine driving the air compressor, if the air is not heated before use in the motor. Heating and expanding the air before passing it to the motor increases its efficiency to 45%. In mining work this is generally difficult; but Mr. FREDERICK HURD, in 1872, placed a heating apparatus inside the valve chest, in which the oxygen for the combustion of the fuel (a mixture of coke and scrap iron) was supplied by the air working the motor. By this he carefully avoided the possibility of explosion by fire damp and the formation of ice.

In practice 40 lbs. to 50 lbs. is about the pressure now adopted for working compressed air machinery; though in rock drills, where lightness, portability and smallness of connecting hose are of more importance than efficiency, pressures of 70 to 90 lbs. per sq. in. are frequently used. The final result, however,

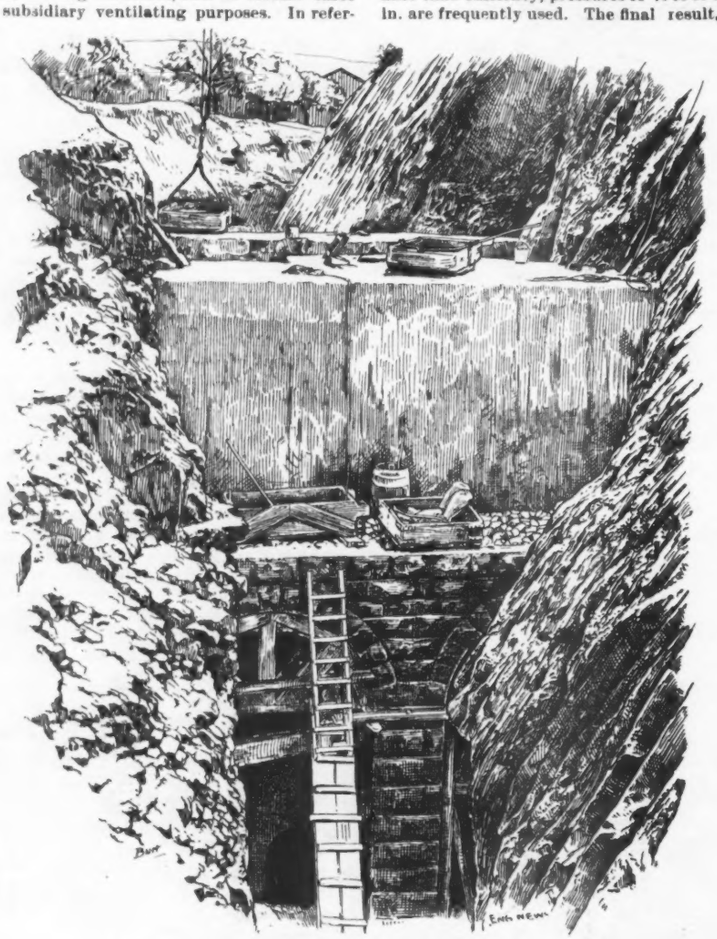


FIG. 7. OAK RIDGE GATE HOUSE, SHOWING ROCK CUT.

is that it is impossible with compressed air to transmit to the distant motor more than from 20 to 30% of the power expended at the engines, and taking into account the friction and loss by piping, the average efficiency is nearer 20%. In the case of electrical transmission, except when distributed in very small units, there is little difficulty in obtaining 50% of the power expended, and there are cases in which no less than 75% is transmitted without extraordinary precautions being adopted. As these figures are frequently contradicted by advocates of compressed air, the authors have selected a simple case and give it as follows:

System.	Brake HP. of steam engine	Brake HP. of motor.	Dist. engine to motor yds.	Size of cable or pipe.	Price of engine and dynamo or compressor.	Price of cable or pipe.	Price of motor.	Total cost of plant without erection.	Efficiency %.
				ins.	£	£	£	£	
Electric.	15.4	10	2,000	7-16	1,050	960	475	2,495	65
Compressed air.	33.3	10	2,000	4	650	3,500	315	4,465	30

The size of the cable plays an important part in determining the efficiency of electric transmission of power. In the case of steam, compressed air or hydraulic transmission, the losses in the pipes are frequently neglected, as they are usually small. This is not the case with electricity, because the cost of the copper conductors forms a considerable item in the whole plant, and then, unless the cables are proportioned to the power to be transmitted, they become heated and damaged by the current passing through. A long table is given in the paper showing the losses in each part of an electrical pumping system; first with a pump delivering 350 galls. per minute in a 900-ft. vertical lift, and a 6-in. pipe line 1,800 yds. long; and second, a similar pump delivering 200 galls. per minute 480 ft. high through the same pipe line. The result shows that an efficiency of 67% can be readily obtained even when transmitting nearly 100 HP. to a distance of more than 2 miles, without any attempt to get specially good results, and the whole plant capable of being worked by unskilled men.

One of the most important points raised against the use of electricity in mines is that relating to its safety, in view of the explosive nature of the gases existing in some parts of most mines. The authors resolve this problem into two parts—(1) Will a motor working under ordinary and satisfactory conditions be likely to cause an explosion, assuming that it is placed in the positions where motive power is usually required in mines? (2) Is it possible under what may be termed extraordinary, but perfectly realizable conditions, to produce an explosion under similar circumstances?

The following is presented as a summary of the results of experiments bearing upon these questions: In the case of an ordinary motor working up to, say, 500 volts, having the brushes properly adjusted upon the commutator, no sparking can be perceived. But, if from wear of the contacts during the long runs, or variation in load, slight sparking should occur, it is produced in contact with large masses of a highly conductive metal (copper), with the result that the rise in temperature is not sufficient to form explosive mixtures of coal gas and air, or ordinary marsh gas and air. The temperature required to explode these gases at ordinary pressures may be taken to be, for a mixture of 1 volume of coal gas with 5 volumes of air, or for a mixture of 1 volume of marsh gas with 9.4 volumes of air, from 900° to 1,100° centigrade.

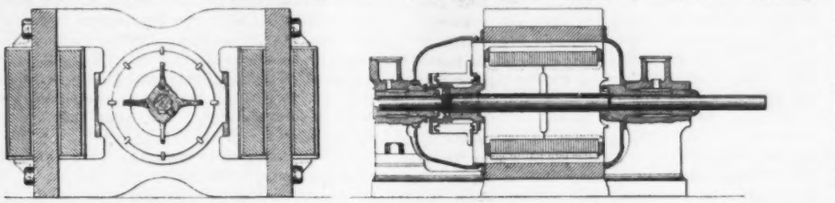
Copper combines with oxygen in air to produce oxide of copper at about 700° C., and as under normal conditions the formation of oxide is not observed, either on the collector or point of the brush, this fact may be taken as further evidence that the temperature existing there is not sufficient to form an inflammable mixture of gases. But while not dangerous under ordinary circumstances, the extreme wear of a brush or its serious displacement may cause an amount of sparking that will raise the temperature sufficiently high to oxidize the copper of the brushes and ignite gas. The question then arises how it is possible to obviate this danger.

The authors have adopted the methods shown in Figs. 1, 2, etc., as a means of excluding from the armature the atmosphere in which the machine is working. It is assumed that the machine will not normally be placed in an explosive mixture, but it is intended to guard against the accumulation of such gases in the case of motors unattended for some hours at a time. Means should also be adopted for stopping the motor when placed at the coal-face or in a heading, in case of an inrush of fire damp, from the fall of roof, or from other reasons. It should be stopped before the explosive gas reaches the motor.

To effect this the authors either inclose the whole armature, with its commutator and brushes, or when this is inconvenient, the commutator and brushes only, in a practically air-tight casing. This plan has been successfull y applied to motors devel oping from 1 to 45 HP. It is now recognized that in the winding of field magnets any desired temperature of working may be obtained by allowing well defined amounts of external cooling surface for the dissipation of the heat developed. This proposition for a final temperature of 70 degrees Fahr. above the atmosphere may be taken as 2.3 sq. ins. per watt to be dissipated. The armatures of ordinary dynamos and motors are constructed to revolve in contact with the air, and the continual cooling thus obtained

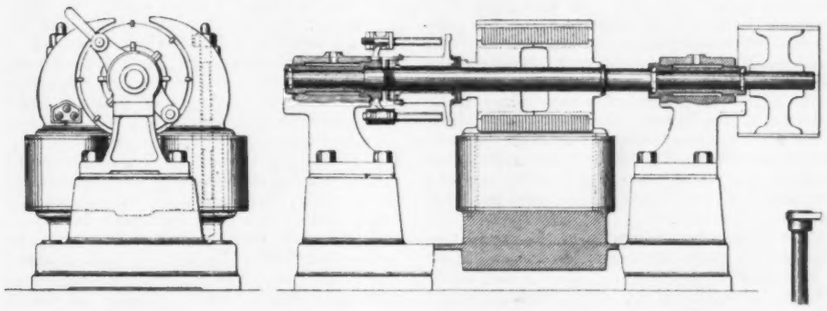
allows the surface for each watt to be reduced to about 0.7 sq. in.

The argument of the mining engineer is that if these casings should become filled with an inflammable mixture and ignited, the result would be as disastrous as if they did not exist. The answer to this is that under certain sections of the Coal Mines Regulation Act it is not allowable to work when the proportion of explosive gas exceeds about 1 in 30, and it is not likely that any electric motor will be placed in such a position as to run continuously in any explosive atmosphere for a longer period than 2 to 3 hours at the outside. These casings are tightly fitted at all points, many of them packed with rubber, and it is not likely that an inflammable mixture could penetrate to a dangerous degree in that time. Should there be any leakage, however, into the covers, as soon as the proportion of marsh gas in the air reaches 3 to 4% combustion will take place quietly, producing carbonic acid gas, which will tend to prevent explosions.



Cross-Section. Longitudinal Section

FIGS. 1, 2. 14-HP. GOOLDEN ENCLOSED MOTOR.



End View. Longitudinal Section.

FIG. 3. 21 HP. GOOLDEN DYNAMO.

If it is required to work for long periods in such an atmosphere, the authors provide means for the introduction into the armature of an inexplosive mixture. This is most simply done by attaching to the motor a steel cylinder containing carbon dioxide under pressure, and connecting this with the armature casing by a pipe which would allow a slow, constant stream of this gas to reach the interior of the casing. The value of this method is evident when it is pointed out that the presence of 14% of carbonic acid gas in the most explosive mixtures of fire-damp renders them absolutely uninflammable.

In the opinion of the authors the switches present a more serious difficulty than the motors, and they have endeavored to meet this in two ways—by diminishing as far as possible the tendency to sparking, and by arranging a switch which even in the event of a spark would be safe under any conditions likely to occur. The plan adopted is, in a series-wound dynamo to provide a resistance coil of small self-induction, which is always connected with the ends of the magnetic coil, so as to form a path through which a current in the latter may continue, even when the main circuit is broken. In the same way, they have arranged the switch in such a manner that before breaking the circuit the coil of the magnets is short-circuited.

By this means the act of breaking the circuit reproduces the conditions which exist in the case of a shunt-wound generator and shunt-wound motor, and the only sparking which results is that due to the self-induction of the line and armatures. To diminish this latter, the switch itself has, on its lower side, a resistance coil connected to the several points with which it makes contact, the wire being large enough to carry the current for the short time during which the switch is passing over them. Even when the generator is short-circuited, the current is so far diminished that if the switch be moved slowly over the contacts, it is less than what has been termed the critical magnetizing current of the dynamo. The result is that by the time the circuit is open the series-wound dynamo has practically ceased to excite itself, the electromotive force and current are very small, and the sparking is practically nil.

As an additional safeguard, the switch itself is made in the form of an air-tight box, which will exclude an explosion mixture for many hours. This switch is illustrated in Fig. 4.

The paper continues with a semi-historical sketch of the application of these principles to working machinery by the authors and by others. But this portion and the discussion which follows are too voluminous for insertion here, though an abstract is given of the latter. The authors conclude, however, with the following summary of the advantages of the electrical transmission of power as deduced from general experience:

(A) Electrical power is destined to become an important factor in mining mechanics, on account of—

1. The greater facility with which it can be used with machines which require to be moved from time to time as the work advances.

2. The great economy in first cost and reduced cost of working, owing to its efficiency being higher than that of compressed air or any other medium of power transmission.

3. The smaller cost of maintaining the cables, as compared with piping, on shifting floors, in roadways, etc.

(B) That the methods described are sufficient to obviate all objections to the use of electric motors in coal mines, either by excluding inflammable gases or by constructions which allow of their safe combustion.

(C) That experiments, trials and practical work, extending over four years, show that—

1. Electrical pumps may be used with advantage and economy for mine draining.

2. Electrical coal cutters can replace hand labor, with saving in cost and increased production of coal.

3. Electrical drilling machines are available in place of machines worked by hand or compressed air.

In the discussion which followed the reading of this paper, the following points may be selected from much relating to coal-cutting machinery: Mr. SNELL laid special stress on the kind of cable employed in wet and dry mines. Lead-covered cables protected by an outer serving of braided and ozokerited hemp he found best suited and most durable for wet pits and shafts. They were also used for permanent main roads and levels; but in rough roads, with falling sides or heaving floors, he preferred an insulation of vulcanized rubber well served with braided hemp, as being more flexible. In shafts he always boxed the cable to protect it from falling stones. He thought that wherever water power was available electricity was the cheapest form in which power could be transmitted. At St. John's colliery, Normanton, electricity had been substituted for compressed air for main haulage and main and dip pumping, with result that the original engines and boilers had given rather more than twice the useful effect previously obtained. His company had several convenient forms of portable motors for coupling to Ingersoll percussion and rotary drills.

Prof. ARNOLD LUPTON objected to the comparison made by the authors as to the relative cost and efficiency of electricity and compressed air. He thought a 3-in. pipe would have been large enough, at $1,000 less cost, and that proper electric mains would cost $500 more than stated. He also thought there would be trouble in distributing power or in running machines at half speed, but he gave no figures for his objections. Mr. GROTHE called attention to the fact that the United States was far ahead of England in the application of electricity to useful work, and gave statistics of street railways, street lighting, mines, etc. Mr. BAINBRIDGE said that in the case of pumping there was no comparison between electricity and compressed air. He was operating a pump that raised 50 galls. per minute 400 ft. high at a distance of 2¼ miles from the engine, with a first cost less than one-half that of compressed air.

Mr. JOHN TAYLOR referred to a California gold mine, where water power was to be secured within 2 miles of the mine. This was utilized by a Pelton wheel, 87 ins. diameter and developing 125 HP., with 400 miners' inches of water under 100 ft. head. This wheel drove a 100 HP. Brush generator, and the current was transmitted to the mines, 1,400 ft. above the power station and 10,890 ft. distant, by a No. 3 insulated copper wire less than ¼ in. in thickness. The length of the circuit wire was 22,588 ft. At the mines was a Brush motor working up to 60 HP. actual; this drove a ten-stamp battery and 3 Huntington mills, or the equivalent of a 40-stamp battery, and a large rock-breaker in addition. It also lighted all the works. Experiments made showed that from 83 to 85% of the HP. generated was practically received at the mills, 2 miles away. A wire two sizes larger would have transmitted 90%, and the electricians of the Brush Company stated that they might safely depend on 70% at a distance of 12 miles.

Prof. HENRY ROBINSON, who was interested in the compressed air plant at Birmingham, stated that the average efficiency of 34 motors worked by compressed air at 45 lbs. was 42.66%, and this could be taken as a fair average of the good with the bad compressing machines. In another case a 40 HP. engine worked with the air heated showed an efficiency of 73%. In other words, he wished it understood that great advances had been made in a few years in air-compressing machinery.

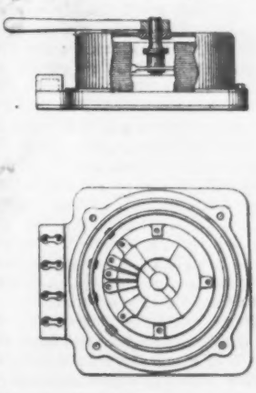


Fig. 4. Enclosed, Non-Sparking Switch.

Mr. FREDERICK HURD said that he was using electrical coal-cutting machinery, and thought the dangers were exaggerated; he had seen machines sparking at a rate that would amaze some people, without causing explosions. His firm was contracting to take out coal at 1s. 6d. (36 cts.) per ton, finding the machinery, keeping it in order and providing the men. They were receiving large royalties, and had declined to sell the machinery to the mine-owners, who would have been glad to close the existing contracts.

Mr. E. R. DALBY thought the risk from sparks from picks was almost as great as that from the commutator of a motor. He referred to the experiments made after the disastrous explosion at St. Etienne, in France, and to the fact that the board of investigating engineers found that picks of aluminium bronze with 2% silicon alone produced no

sparks. This board, however, failed to produce explosions with the sparks from any of the picks used.

Mr. HOWARD D. PEARSALL objected to the statements made regarding efficiency and cost. He said that Mr. TAYLOR had stated that the efficiency transmitted at the California mine was 85%; but that was solely the efficiency of the conductor, and meant that 15% of the power was lost in transmitting it 2 miles. The loss in transmitting compressed air through 3 miles of pipe, at Paris, was only 2%, on the authority of Prof. KENNEDY. In the Paris installation the efficiency of the prime mover was 84.5%, and that of the compression was 61%. The product of these was 51.5%. In compressing air by water power he had obtained an efficiency of 85% and a net efficiency of 67% at a distance of 3 miles.

In answering Prof. LUPTON'S objections, the authors stated that their prices were average market prices, and they had adopted a 4-in. pipe in the table given because this had been recommended by all makers of compressed-air machinery whom they had consulted. To meet an objection that the distance of transmission was not sufficient, they had prepared the following table, with a transmission equal to 10,000 yds.:

COMPRESSED AIR VS. ELECTRICITY.

System.	Size Pipes.	Engine B. HP.	HP. given by Generator.	HP. Lost in Main.	HP. Put into Motor.	Motor B. HP.	B. HP. Motor. / B. HP. Engine.	Cost Complete and Erected.
	ins.							
Air	3	62.1	38.	19	19	10	0.16	$12,500
	4	39.	23.6	4.6	19	10	0.26	15,500
	5 & 4	35.8	21.8	2.8	19	10	0.28	17,225
Electricity	19/17	19.2	16	4.6	11.4	10	0.52	7,900

As to the danger and annoyance from stoppage and breakdowns, the author said that as a matter of fact a dynamo driving the author's coal cutting machines was used regularly for two years without any repairs or breakdowns. As to Mr. PEARSALL'S remarks that compressed air with an efficiency of 85% was an accomplished fact, the authors regret that he did not specify where it was to be seen, as a large number of engineers would be certainly interested in this unique result.

Steel Foundations.*

(WITH INSET.)

The prairie soil underlying the city of Chicago is unfavorable to the construction of heavy foundations. The character of the strata changes materially even in short distances. In general, however, there are 6 to 12 ft. of loam and quicksand, then a layer of clay, which is hard and firm in some places but in others so soft and wet that it may be readily taken out with a spade. In the business section of the city, where all the great business blocks are located, the clay, often mixed with strata of quicksand, reaches down from 40 to 80 ft. to a limestone foundation. Generally a few feet down the clay grows softer and wetter. If any of it becomes solid and hard, or there are any hard-pan layers within the reach of ordinary piles, there seems to be no indication that they are uniform or at all to be relied upon.

Until recently heavy foundations were commonly built of stone and concrete resting on the clay. In later years, however, this method has not given satisfactory results. The demand for all the space in the basements of great buildings has yearly grown more urgent. Either the bed of the foundations must be lowered, the foundation itself must be made thinner or some entirely different method must be employed. The first of these alternatives has been very generally ruled out, because it has been demonstrated very clearly that the less the clay stratum is broken, the more uniform and satisfactory is the settlement of the building. Other methods have been tried repeatedly—piles have been driven, and sometimes timberwork has been combined with masonry and concrete, but the results thus obtained have also been generally unsatisfactory. As an example, the Cook County Courthouse, which was built on piles, is reported to have settled over a foot and very unevenly. There are still some, however, who advocate their use. If the piles could be driven deep enough to rest upon some hard bottom, they might give us a permanent, unyielding foundation; but, judging by results so far obtained, the method is not nearly as reliable as the direct clay bearing.

The drift of practice has been to make the foundation thinner with the use of iron, spreading out on the top of the clay without materially breaking it. At first it was only in a half-hearted way. Many old rails were used, and they were sometimes laid very unscientifically. But the practice has steadily improved. New rolled rails and heavy beams are now employed, and they are as carefully calculated for their work as any other iron in a building. This evolution has produced an entirely new type of foundations—a substitute for heavy masonry and huge blocks of concrete. Let us see how fully it has met the problem.

The site of the building now being constructed by the Women's Christian Temperance Union was previously intended for another structure, all the foundations of which were put in place some years ago. These were made of great piles of masonry, one for each column, all underlaid with a bed of concrete resting on the clay stratum about 10 ft. below the street grade. This great quantity of stone so cut up the space below the street level that nothing was left available for basement use. There are now acres of buildings in the very heart of Chicago without any basement, and on this very account. In this case all the masonry has been removed, and new steel foundations have been placed on the old bed of concrete so well designed that all the basement space is available. This is the great difference between the two methods which every one first notices, and which, of course, tells most from the financial stand-point.

Fig. 1 on the inset is a section of the foundation of one column in the building referred to, and Fig. 2 is a section of a pyramid of stone which might have been used in its place. They are presented for a detailed comparison,

1st.—As to the space occupied.

2d.—As to weight.

3d.—As to cost.

4th.—As to time required for building; and

5th.—As to clay surface which can be loaded.

The underlying course of concrete is the same in both cases. In the former, the distance from the top of the concrete to the bottom of the cast-iron base is 1 ft. 8 in., and in the latter it is 7 ft., or four times as high as in the steel foundation. This is the great difference that makes the one more valuable than the other. The space saved is basement floor room. Still, comparing the part above the common bed of concrete, there will be fouhd 217 cu. ft. in the former and 691 cu. ft. in the latter. Rating the weight of the masonry at 150 lbs., concrete at 140 lbs., and allowing 44 cu. ft. for the steel in the former, the total weights of the two are 103,000 lbs. and 261,000 lbs. respectively. The load which this foundation carries is about 800,000 lbs., and the saving in weight is sufficient to permit an additional story in the building without adding to the load on the clay. On large foundations this difference is still greater, and the foundation is likewise a larger part of the whole clay load. In the case given here the 103,000 lbs. is about 13% of the load it carries, but in some cases under very heavy loads it has been found to be quite 20%. This saving in weight is one of the factors which have made 16 and 18-story buildings possible. These lofty structures are not loading the clay as much as some of our lower and older buildings. The secret is in lighter loads, and in this way the foundations themselves have come in for a part of the credit.

In the time required for building, the iron foundation has a great advantage, at least in Chicago. If rails are used, as in the case given, the rails can be placed on the ground in two or three days, and when all the material is at hand and excavations completed, the whole foundation can be put in place in a few hours. This is oftentimes a very great advantage, and alone a sufficient consideration for the employment of this type of foundation.

The cost of iron foundations varies exceedingly, depending principally upon prices of material, the ingenuity of the engineer, and the familiarity of the workmen with that sort of work. In the cases referred to, the cost of the two would probably not have differed greatly. In general, the cost of the stone foundations will figure somewhat under that of iron, but compared with the cost of foundation per sq. ft. of renting area, which is the proper way of doing, this difference will be eliminated.

The fifth point of comparison is also an important one. It often occurs that heavy column loads come close to some old building or to another man's lot, so that it is impossible to spread out alike on every side. In such a case as this, the area between this and some other column can be spanned with steel beams, making a compound foundation and utilizing an area that could not be used at all with masonry. Oftentimes in this way a foundation is made with two loads—one on each extreme end. Fig. 3 on the inset shows the areas covered by foundations in a part of "The Fair," corner of Adams St. and Dearborn St., in which a number of compound foundations have been made. The plan shows only the clay areas covered.

The clay loads most generally used through the business center of Chicago vary from 1½ to 2 tons per sq. ft., the tendency being for the former rather than the latter. With this load the structure will settle from 3 to 5 ins., and this is usually provided for by reckoning everything that much too high at the start. Settlement comes slowly, but none the less surely. It comes in proportion to dead loads, and is dependent in some measure upon the perimeters. The whole subject presents a most interesting field for study, and one in which there is much to be learned. The judgment of practical builders who have the best opportunity for observation confirms the theory that clay areas should be proportioned to dead loads only. Where live loads are figured into clay loads for interior columns and exterior walls, the walls invariably settle the most. The reason will be found in the fact that the live load is a greater per cent. on the whole load on the columns than it is of the load on the walls. The difference in length of perimeter for wall and column foundations must also have some effect, and a similar one. In most buildings it is desirable to count a fraction of the live load in the total load on the columns, and consistency requires that whatever load is placed on a basement column should also be put on all the iron under the basement column. On this account it happens that while the area on the clay is calculated for dead load only, the beams in the foundation must sometimes be calculated for some live loads, and iron loads and clay loads must be kept separate and distinct. In general, the center of gravity of the load should coincide with the center of gravity of the clay area covered. In compound foundations this sometimes becomes complicated.

The concrete used is made of the best Portland cement, usually one part with four parts of crushed stone and two parts of coarse sand. Steel rails weighing 75 lbs. per yd. are mostly used where beams are not required. Seconds are found to answer quite as well as the first quality, and the chances are that for the length required they will be quite as good as the best, and if any flaw does exist the chances are few that it will come where the maximum bending moment occurs. In ordinary foundations they are more economical than beams. More iron is required, but the rails can be bought for about one-half what the beams cost, thus more than covering the difference in weight. It is easier to place the concrete when rails are employed, and the webs are always thick, two other good points in favor of the rail. If heavy loads must be carried with a few pieces, as is often the case in the top course immediately under the column, heavy beams are a necessity. This is also often the case where long spans are required. The sizes generally used are 10, 12, 15 and 20-in., and more of the larger sizes than the smaller. There is no advantage in having the iron in direct compression, and only that part projecting is strained to its usefulness as a beam. Therefore it follows that the place for beams is at the top of the pile, and that the larger the proportion of iron uncovered the greater the economy of the structure.

In designing foundations the engineer first decides on the general arrangement to be used, the sections to be generally employed, unit strains, etc., all of which is dependent in a great measure upon his judgment and experience. This done, each foundation is treated on its own merits and each course of

* Contributed by CONGDON T. PURDY, C. E.

iron is separately calculated. The following shows how this was done for "The Fair," which is one of the largest buildings in Chicago, now in course of construction. Reference has already been made to Fig. 3 on the inset, which shows the clay areas covered in one section of this building. In this case it was decided to use heavy beams for the top course, and, whenever possible, to use rails for the remaining courses. Also to use 20,000 lbs. ultimate fiber strain in the former and 16,000 lbs. in the latter. Fig. 4 shows the arrangement of steel in the foundation of one of these columns on a larger scale. In the plan the steel is shown without the concrete filling, but in the section the concrete is drawn. In actual practice such elaborate drawings are not made, and Fig. 5 is given to show the same thing, as it was drawn for the use of the workmen when placing the beams in position.

The top course in this case is composed of 15" steel beams weighing 50 lbs. per ft., whose moment of resistance equals 117,700 ft. lbs., and the other courses are made of steel rails weighing 75 lbs. per yard, measuring 4¾ ins. in height and width of base and having a moment of resistance of 12,100 ft. lbs.

The projecting arms of the two upper courses are to be determined. They should be as great as possible. Those of the two lower courses are fixed by the length of the upper ones and the dimensions of the clay areas which are previously calculated.

In the two upper courses as many pieces are used as the space will admit of, and the question is, how far will they project? In the lower courses the projection is given and the question is, how many pieces are required?

The formula used for the two upper courses is as follows:

Let y = the projecting arm.
l = the total load.
a = the width of supported area.
and M = the total bending moment on one side of the load.

Then the total length of beam or rail $= 2y + a$.

The total load on $y = l \frac{y}{2y + a}$, and since the distribution of the load in every course of iron is uniform,

$$M = \frac{l\,y}{2\,y + a} \times \frac{y}{2} = \frac{l\,y^2}{2\,(2\,y + a)} = R.$$

In calculating the two lower courses, y becoms a known quantity and M the unknown. The load on this column is 1166000 lbs. The operations in this case are as follows: For the top course,

$$M = R = 117700 \text{ lbs.} \times 9 = 1059300,$$

as not more than 9 beams can be put under the cast base plate. Then

$$\frac{1166000 \text{ lbs.}\ y^2}{2\,(2\,y + 5)} = 1059300.$$

$y = 5'\ 4''$, and

$2y + 5 =$ length of beam $= 15'\ 8''$.

For the third course,

$$M = R = 12100 \times 31 = 375100 \text{ lbs.}$$

This spaces the rails 6 ins. center to center. They can be put closer if necessary.

The load = 1,166,000 + 19,000 (= weight of top course iron and concrete) = 1,185,000 lbs.

Then,

$$\frac{1,185,000\ y^2}{2\,(2\,y + 5)} = 375,100 \text{ lbs.}$$

$y = 2$ ft. 6 ins. taken at 2. ft. 5 ins.

The area covered by the first course must be 15 ft. 11 ins. × 21 ft. 4 ins.

This leaves 3 ft. ½ in. for the projection of course one, and 2 ft. 10 ins. for the projection of course two.

$$\frac{1,200,000 \text{ lbs.} \times 2\frac{5}{6} \text{ ft.} \times 1\frac{5}{12} \text{ ft.}}{21\frac{1}{3} \text{ ft.}} = M = 225,780$$

Requires 19 rails in course two.

$$\frac{1,220,000 \times 3\frac{1}{4} \times 1\frac{23}{24}}{15\frac{1}{2}} = M = 343,000$$

Requires 29 rails course one; 30 rails were used.

In putting these foundations into position, the workmen first make a plank frame the same size as the concrete bed and place it carefully into position, making the top of it, with the use of a Y level, the exact height which the top of the concrete is expected to be. After this is filled, another frame is arranged for the next course, and so on to the end. The rails for each course are spaced equally. The concrete is carefully tamped between, completely imbedding the iron, and as soon as one course is completed the next one can be begun. After all this is done the boxes are taken away and the whole is carefully plastered with Portland cement mortar, so that at no place is the iron exposed.

It seems as if these steel foundations might be used in other places, where bed rock cannot be had to rest loads upon and where real estate is very valuable, though perhaps it would be difficult to find another place where they so perfectly fit the need as in Chicago. They are peculiarly well adapted to compound foundations where the position of loads with reference to each other is bad, and the areas which the foundation can cover are limited. This need is very liable to occur in any large building—a tower between walls, a heavy chimney stack, or a badly arranged cluster of columns where it is almost impossible at best to distribute the loads so that they shall bear evenly upon the soil. In such places, if the load is not distributed, there will come an unequal settlement, and the bane of foundation is not that they settle, but that they settle unequally. Oftentimes in the arrangement of machinery it becomes necessary to build great pits almost adjacent to the bearing of heavy loads, and where the cutting of the masonry almost destroys the proper distribution of the load over the area expected to carry it. Here again the use of beams in conjunction with the masonry may be to the great advantage of the structure. Indeed, wherever the proper distribution of loads becomes difficult iron may be made a valuable adjunct to the masonry.

The question of the durability of iron imbedded in concrete can only be definitely answered by time itself. So far wherever iron has been taken out it has been found well preserved. Chicago architects and builders are showing their faith in it by constant use, though wiseacres still shake their heads and prophesy that some day the rail will become a streak of yielding sand.

Shaft-Sinking Through Wet Gravel and Quicksand Near Norway, Mich.*

An extensive swamp covers a large part of the town site of Norway and adjacent land. Through this swamp run parallel two ore formations. In the north one is the Aragon mine. The south one passes into the swamp on the Harrison property. On the edge of the swamp, about 1,000 ft. from the Aragon mine, a diamond drill, in the fall of 1889, located the ore-bearing formation and a probable ore body. To explore further and develop this ore, the Penn Iron Mining Co. proposed, in the spring of 1890 to sink a shaft.

The drill had shown the depth of the glacial drift to be more than 60 ft. A test pit near the location of the proposed shaft had struck, at a depth of 20 ft., an amount of water which a 200-gall. pump was unable to lower. At the Aragon, a few years before, a shaft has been sunk to hardpan with great difficulty and many delays by the usual method of driving laths.

Under the conditions it was decided to sink a caisson or drop-shaft. Two 40-HP. boilers, a Lidger. wood engine with 4-ft. drum and a good derrick were set up; and 2 No. 10 Knowles pumps, rated at 400 galls. a minute, were brought on the ground. The pumps had been purchased for another purpose, and, being brass-lined, were not well suited for the work intended, but they were available.

The dimensions adopted for the top of the shaft were 6 ft. × 13 ft. inside. To give sufficient space for pumps and working, and to aid the shaft to settle, it was made 4 ft. larger each way at the bottom. The shaft was divided, to within 12 ft. of the bottom, into 3 compartments, the middle one uniformly 4 ft. wide. This compartment was used for hoisting, a ladderway and pipes. The pumps were placed one in each end compartment. Above the pumps the end compartments were planked up to be filled with sand to increase the weight. A ventilation box was put in one corner. The bottom of the shaft was left unobstructed for working purposes, and sufficiently high to allow two additional pumps to be put in under the first. (See Fig. 1.)

The bottom pieces made of oak, and constituting what is called the shoe (see *A A*, Fig. 4), were 15 ins. square, but the bottom inside was bevelled off to 6 ins. Above the shoe, white pine timbers (*B B*), 12 ins. square, framed in sets, were laid close and bolted together and to the shoe with eight 5-ft. bolts. The successive sets were reduced 1 in. in length and width, until at 48 ft. above the bottom their dimensions corresponded with the top. Corner posts 12 ins. square, of unequal lengths, so as to break joints, were bolted to every other side piece and end piece. The bolts, being put in from the inside and having the nuts countersunk, were easily unscrewed and recovered when the corner posts were removed.

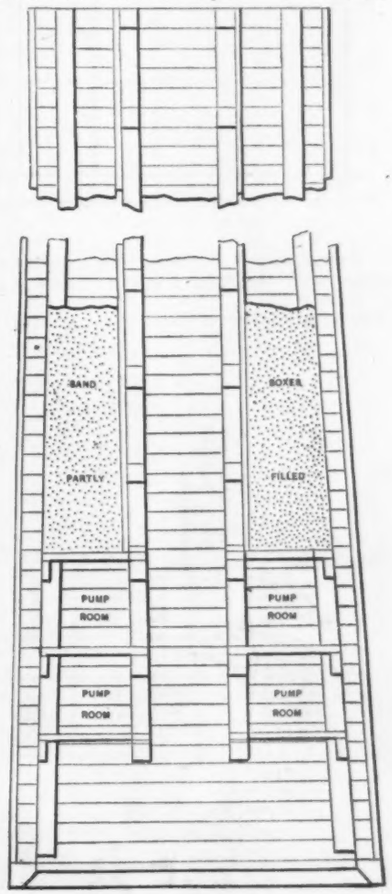


Fig. 1. Longitudinal Section.

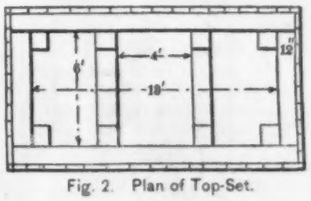


Fig. 2. Plan of Top-Set.

Like the corner posts, side posts were put in, one at each corner of the middle compartment. Twelve-inch dividers were used every 5 ft.

After the leveling of the ground the timbers were built up and and bolted as far as the derrick and bucket would permit, nearly 30 ft. The seams were then carefully caulked outside, and 3-in. planks in unequal lengths were spiked on, to protect the caulking and timbers and to strengthen the shaft. A shaft of this character is liable to be pulled apart if not very strong.

Steam hose was used at first to connect the pipe on the ground, coming from the boilers, with the pipes in the shaft. But afterward lengths of pipe with double elbows were substituted. Two lines of steam pipe from the ground to the pumps were necessary, in order that one could be used while the other was being altered in building the shaft up.

The shaft erected, the pumps in place and everything ready, ground inside the shaft was broken Monday morning, June 2, 1890. As the top was dry, the buckets came up fast, and by next morning the shaft had gone down 6 ft. On Friday, the fifth day

*By WILLIAM KELLY, Vulcan, Mich., in Transactions of the American Institute of Mining Engineers.

at 15 ft., the pumps had to be started. The first week's work resulted in 18 ft. sunk. During the first 3 days of the second week 9 ft. more were sunk. At this time it was evident that both our pumps had to run fast to keep the water out, and if one should break down or the water should increase we would

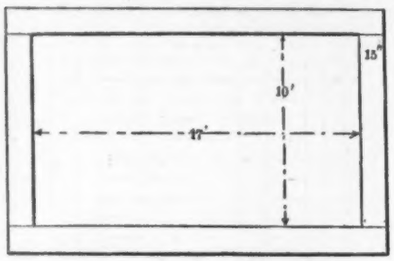


Fig. 3. Plan of Shoe.

be drowned out. Therefore, before sinking the pumps below the water level we stopped to get more power.

Two portable boilers, of 35 and 100 HP. respectively, were bought, delivered and connected, and 2 No. 10 Cameron pumps were placed, without air chambers, 4 ft. under the Knowles pumps. During the stop the shaft was built up again as high as possible. We lost thus 15 working days, but started afresh Monday, June 30, with double power. During the next 3 days we sunk 7 ft. Then the Knowles pumps gave out. Eight days of sand and gravel had completely worn out the brass linings. It was necessary to take out the linings and put in larger pistons, which repairs consumed 2 days.

On Saturday, July 5, we started again, and to the end of the following week we sank 16 ft. in 7 working days. During this time everything went well. The pumps were kept busy, 3 running constantly, and the Knowles pumps often making 160 strokes a minute. The quantity of water was estimated at 1,500 galls. a minute. During this week the sandboxes were filled to keep the shaft down to the bottom of the excavation. The sand and gravel would come in under the shoe, and the surface about the shaft settled into a large pit, which continually grew larger.

At this time, July 12, the shaft was down 50 ft., and it became necessary again to build it higher. This took 3 days. A drill in the bottom gave us some encouragement, as at 10 ft. it struck something hard. During the next 3 days we sunk 7 ft. and found hardpan in a corner of the shaft. At this point the shaft did not settle well, even when the ground was out a foot or more from under the shoe. To increase still further the weight of the shaft, 30 tons of rails were laid loosely on the top. While going through the hardpan the settling of the shaft was irregular, accompanied by inrushes of sand and water, which kept the pumps busy. Props had to be placed against the shaft at different times to keep it straight. It took 18 days to go through the 14 ft. of hardpan; but parts of 2 days were spent in

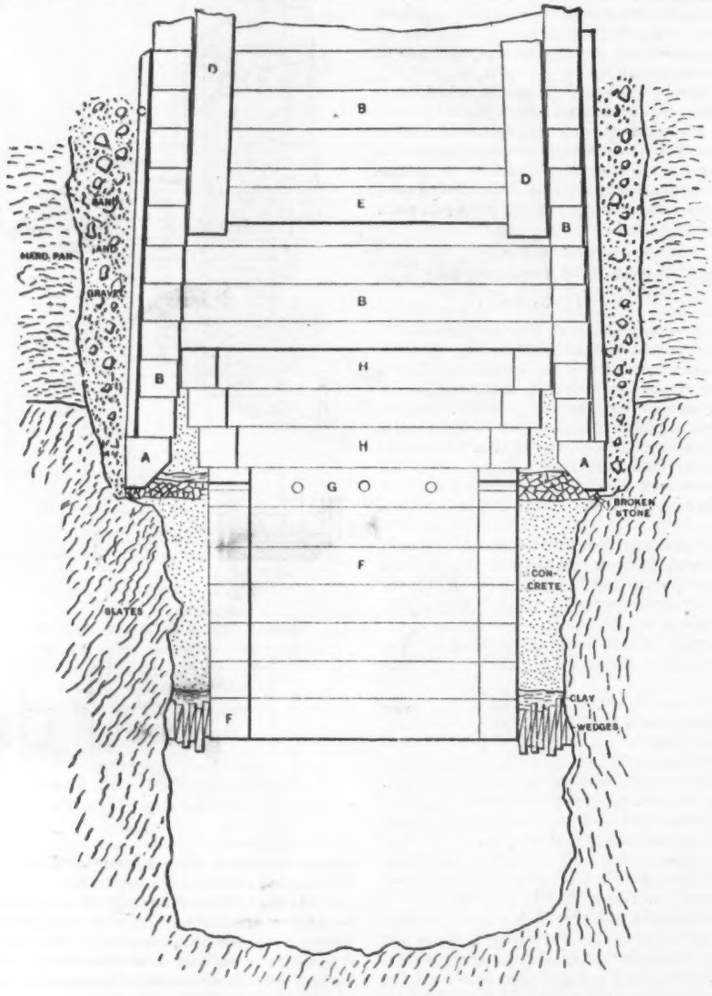


FIG. 4. HARRISON SHAFT. METHOD OF CLOSING BOTTOM.

weighting the shaft and one day with an accident which bade fair to stop proceedings summarily.

Some difficulty with the water supply of the boilers cut down the steam pressure so low as to stop the pumps, and before steam was raised again they were completely drowned and could not be reached. An anxious quarter of an hour was passed before the first one, then another and then a third pump, started of their own accord under water.

The ledge was struck Aug. 7, and 2 days later the slates were exposed all across the shaft. Four days more were spent getting the shaft down 2 ft. farther into solid rock.

The time spent in sinking may be summarized as follows: 4 days sinking 15 ft. above water level; 17 days sinking 42 ft. through wet gravel and quicksand; 16 days sinking 14 ft. through hardpan; 4 days sinking 2 ft. in slates; making a total of 41 days sinking 73 ft. To this must be added 6 days required to build up the shaft and 2 days weighting shaft with rails, or a total of 49 days, or one day over 8 weeks actual working time. In addition to this we lost 12 days in increasing our power and 2 in repairing pumps, making the time engaged 63 days, or 10½ weeks.

We now, Aug. 14, had the shaft down firmly in the ledge; but the most delicate part of the operation was still to come, namely, stopping the flow of water. Before that could be done, however, many things were necessary.

The rails had to be removed from the top and the sand from the boxes, the pipes changed and the shaft built up to the surface. There was now a sinkhole about the shaft 75 ft. in diameter and 20 ft. deep, and the top of the shaft was about 6 ft. below the original surface level. The shaft was but little out of plumb, the top set having to be raised 2 ins. at one end to level it. The corner posts were taken out, the boltholes plugged and the shaft caulked on the inside. This work took 8 days.

The next 14 days were spent in sinking 11 ft. farther into the ledge. This work proceeded slowly. It was unsafe to make heavy blasts, and the pumps, after their severe strain with lengthened suctions, were barely equal to their task. The bulk of the water from under the shoe was gathered together by troughs of boards and clay, but still water was falling everywhere.

The work of sealing up the bottom of the dropshaft was now undertaken. A set, 6 ft. × 13 ft. inside, of 12-in. square timber, was carefully placed in line with the top set of the shaft, about 6½ ft. below the shoe. This was thoroughly blocked against the rock all around with wedges. Six sets (*F*, *F*) of the same size were placed on top of the first and each bolted to the next. Behind the sets as they were built up was put a thin layer of clay over the wedges, and then concrete of equal parts of sand and Hilton cement. The middle of the top set (*G*) was about opposite the bottom of the shoe. Through this set twenty 2-in. holes had been bored. Behind the holes a layer 4 ins. deep of gravel and broken stone was laid, leaving a free passage for the water. Upon this perforated set were put three other sets (*H*, *H*) of increasing inside dimensions, so that the top set was against and bolted to the drop shaft. The space behind these sets was filled with concrete as before. This timbering and cementing in such a flood of water was a tedious process and took 18 days.

It was all done, and we were ready to plug up the holes, when the pumps failed. One had been removed to make room for lowering the timbers. The piston rod of another broke and a third would not draw. In a few minutes the pumps were flooded and the water gradually rose to its old level. Then followed 10 days in recovering the shaft by means of other pumps. The perforated set could not be cleared of water, as the broken pump was the lowest and the others could not be got down low enough. The first few holes were plugged without difficulty under 2 ft. of water, but the last one defied us for some hours until we used a long plug reaching across the shaft.

The result was entirely satisfactory. The water at once fell to about 200 galls. a minute. After the pumps and side posts had been removed and the interior had been thoroughly calked, the water was decreased to about 90 galls. After the shaft had been sunk farther and bearers put in, a small station was cut at one end and the water was gathered to a No. 8 Cameron pump. Below this the shaft was sunk with a No. 4 Cameron, which now works about an hour and a half a day.

The time taken for sealing up the bottom may be summarized as follows: 8 days to alter shaft after it rested; 14 days to sink 11 ft. in slates; 18 days to timber and cement; 16 days to remove pumps, calk and arrange shaft for regular sinking, giving a total of 56 days. To this we must add 10 days lost by failure of pumps, or a total of 66 days, or 11 weeks.

This makes the total of both periods of the work 129 days, or 5 months. Of this, 4 weeks was lost time that might have been avoided. At the end of this time, Nov. 1, the shaft was 84 ft. deep and in shape for sinking in the regular way.

Irrigation and Irrigation Systems in San Bernardino County, Cal.

BY F. C. FINKLE, C. E.

(Continued from page 76.)

THE ONTARIO SYSTEM.

Ontario, sometimes called the "model colony," is a citrus colony in the extreme westerly portion of the San Bernardino Valley. The colony was founded by Chaffey Bros., who secured the land and water rights in the San Antonio Cañon, laid out the colony, with a town site, Ontario, in the center, and about 5,000 acres of acreage lots around it. The water rights of the tract consist of one-half the flow of San Antonio Creek, which half has been measured and found to be about 7 cu. ft. per second, and water developed by tunneling into the hills near San Antonio Creek.

The developments in the tunnel are still going on (February, 1891), and it is impossible to state just how much water can be obtained in this way. The tunnel is driven below the point of diversion of the water taken from the creek, the object being to drain the underflow of the stream. The work in its early history was conducted on anything but a scientific plan, and a great deal of trouble was experienced on account of caves. Lately a system of timbering and lagging has been adopted, which is obviating this difficulty, and the work has proceeded more satisfactorily. The material being encountered at present is very hard, and has to be drilled and blasted before it can be removed. Should the tunnel be as great a success as the projectors believe, it will do away with the fear which Ontario people have that a dry year may also diminish the natural flow of the San Ontario Creek as to seriously affect their water supply.

The water of the stream after it is diverted is conveyed in a cement ditch a distance of half a mile to the mouth of the cañon, where a small distributing reservoir has been constructed. From this point the water is conducted in a 22- and a 16-in. cement pipe to the top of the mesa on which the Ontario Colony is located. After reaching the top of the mesa the water is taken a distance of 2,000 ft. in a 22-in. sheet-iron pipe; then another cement main is laid along the upper line of the tract from which the distribution pipes draw their supply. These pipes are of cement, 8 to 12 ins. in diameter, and run south in parallel lines about an eighth of a mile a part.

The town of Ontario is supplied with water under pressure through sheet-, wrought- and cast-iron pipes ranging in size from 2 to 10 ins. Ontario has made a wonderful growth during the 8 or 9 years of its existence, and is now a populous and prosperous as well as beautiful citrus colony.

THE NORTH FORK CANAL.

The North Fork Canal takes its water from the Santa Ana River at the point where the river is about to emerge from the Santa Ana Cañon. The canal has a supply of 12 cu. ft. per second, but was constructed to carry five times that amount; the Bear Valley Co., to be spoken of more particularly hereafter, paid one-half the cost of constructing the canal to City Creek in consideration of being permitted to own one-half the carrying capacity for conveying water from the Bear Valley Reservoir.

The water is diverted from the river into the North Fork Canal by means of a rock dam and a tunnel driven through a spur at the side of the cañon.

The amount of water admitted into the tunnel is controlled by a gate at its upper end. By lowering the gate the water can be entirely shut off from the tunnel and allowed to flow over the dam, down the river in its natural course. After leaving the tunnel the North Fork is a cemented canal constructed on a 2.4% grade to City Creek, a distance of about 5 miles, except in crossing several arroyos and Plunge Creek, over which flumes are constructed. The longest flume is one of 450 ft. across Plunge Creek.

At City Creek the canal drops about 20 ft., and at the lower level divides into 2 branches. One branch is known as the Highland Ditch, which follows along the southerly slope of the San Bernardino Mountains close to the foothills, and the other is known as the continuation of the North Fork Canal, which runs due west along a public highway known as Highland Avenue. Both branches run for a distance of 5 or 6 miles, and cover about 2,000 acres each of fine orange land. The Highland Ditch covers the most elevated portions, and the continuation of the North Fork, the lower portions of the famous Highland orange belt, lying from 4 to 8 miles northeast of the city of San Bernardino.

There is, farther west than the land irrigated by the North Fork Canal, a tract of 10,000 acres of dry orange land on the famous Muscupiabe Rancho, which can be brought under the flow of the North Fork Canal by an extension. This tract has only very small parts, not amounting to over 800 acres, under water at present. The water for this is obtained from Devil Cañon and Twin creeks, from which streams small pipes and ditches are laid appropriating the entire flow of the creeks, which, however, does not amount to over 4 cu. ft. per second.

As the owners of the Bear Valley Reservoir own the surplus carrying capacity in the North Fork Canal, it is believed that they will extend it westward to cover the balance of the dry land in the Muscupiabe Rancho. By means of such an extension they can conduct water from the Bear Valley Reservoir on to the entire tract, which, when irrigated, will be very valuable, as it lies so near to the city of San Bernardino, the commercial center of the valley and the county seat of San Bernardino Co. The North Fork Canal was constructed in a very substantial manner, of first-class materials, and has a splendid system of apportioning the water among the consumers by means of weirs; the land supplied with water from the canal is the cream of the citrus belt of Southern California.

The only criticism to be made of the North Fork Canal is that it is not as well supplied with wasteways for storm water as it ought to be. There are many places where culverts and aprons should have been constructed to conduct storm water from mountain gulches and ravines across the canal. This defect has caused much expense and litigation to the owners of the canal, and, unless it is remedied, will be a source of much future trouble.

THE SOUTH FORK DITCH.

This ditch takes its water from the Santa Ana River on the south side of that stream. The water was originally diverted from the mouth of the cañon and conducted the entire distance in a crude, open ditch, but by an arrangement made recently with the Bear Valley Co. the waters are now diverted into the canal of that company and carried therein a distance of 3 miles. After leaving the Bear Valley Canal the South Fork water is carried in the original South Fork Ditch, which has been much improved. For about a mile the South Fork Ditch runs southwesterly, and is a rough, uneven, open ditch, following the natural slope of the country. Then follows 2¼ miles of rock-paved but uncemented ditch, which follows the road in a westerly direction. This ditch is 2¼ ft. wide on the bottom. 2 ft. deep and 4 ft. wide on top. It is laid up of dry boulders ranging in size from ⅓ to 3 cu. ft.

In addition to what has been above described the works of the South Fork Co. consists of 4 miles of distributing ditch of the same general character, about 1 mile of 14-in. cement pipe and 6 miles of unpaved open ditch. The South Fork works show an entire absence of professional guidance and supervision in all its parts. The outlets for distributing the water are of the simplest kind, being boards slipped down between stakes driven in the ground. It is therefore impossible to distribute the water among the irrigators by measurement and the owners use the whole flow of the ditch for as many hours out of every week as their interest in the ditch entitles them to. The average supply of water belonging to the South Fork Ditch is a continuous flow of from 7 to 10 cu. ft. per second, varying in dry and wet years.

The South Fork Ditch furnishes water to irrigate the settlements of Lugonia and Sunnyside in the eastern portion of the San Bernardino Valley. The tracts adjoin the city of Redlands and are about one half improved to citrus and deciduous fruits and raisin grapes.

An Adjustable Pipe Band for Tapping Cement-Lined Pipe.

A band which can be used for tapping cement lined water mains or for repairing bursts or leaks in such pipes is shown by the accompanying illustrations. Fig. 1 shows the band in place on a section of pipe, and Fig. 2 the band in more detail. As will be seen, the band is in two sections, shaped to fit the pipe and to strengthen the point of application. The need of the latter provision is obvious to all who are familiar with cement-lined pipe.

The band is fitted with a corporation cock, in position, with a rubber washer to prevent leaks. Neither the cock or the washer is disturbed by applying the band, as the latter is tightened by a nut at the top. This is claimed as an advantage over methods requiring the corporation cock to be screwed

Fig. 1.

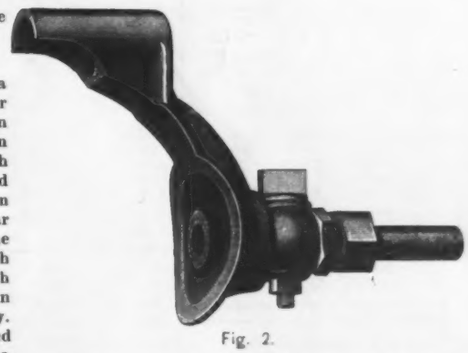


Fig. 2.

against the pipe to make a tight joint as the band is made to bug the pipe by tightening the nut at the top. As the coupling is made with a ground joint no washers are needed. By removing the cock the band can be used as a clamp to repair leaks. The band is furnished for pipe from 4 to 14 ins. diameter. It is manufactured by the Smith & Anthony Stove Co., 50 Union St., Boston.

Railways of the United States in 1890.

The advance sheets of the introduction to the forthcoming issue of "Poor's Manual" contain the usual complete details of railway operations and construction in the United States. From these we abstract the following details of the results of operations for 1890:

According to the Manual the total extent of railway in this country on Dec. 31, 1890, was 166,817 miles. Of this 163,420 miles was completed before the close

of the fiscal year and 157,976 miles present complete statistics of operations. The capitalization of the 163,420 miles completed before the end of the fiscal year is as follows:

Liabilities.	
Capital stock	$4,640,239,573
Funded debt	5,105,902,025
Unfunded debt	376,494,297
Current debt	271,145,220
Total liabilities	$10,393,781,120
Assets.	
Cost R. R. and equipment	$8,789,221,516
Real estate, stocks, bonds and other investments	1,480,560,658
Cash, bills receivable, current accounts, etc., etc	428,035,065
Total assets	$10,697,817,239

The excess of assets over liabilities is $304,036,119.

The results of operations for the 157,976 miles reporting are as follows:

Passenger train mileage	297,244,707
Freight train mileage	482,900,422
Mixed train mileage	13,780,016
Total revenue train mileage	793,925,145
Passengers carried	520,479,082
Passengers—mileage	12,521,565,649
Tons freight moved	701,344,437
Tons freight moved one mile	79,192,985,125
Earnings—Passengers	$ 73,664,439
Freight	740,374,844
Other	72,000,924
Total	$1 086,040 207
Operating expenses	744,373,838
Net earnings	$341,666,369
Other receipts, including rentals received by lessor companies	113,731 846
Total available revenue	$455,398,215
Payments from available revenue:	
Interest on bonds	$220,222,788
Other interest	6.576,894
Dividends	82.303,616
Rentals, tolls, etc	50,129,924
Miscellaneous	35,174,333
Total	$403,407.555
Balance—Excess of available revenue over actual payments therefrom for the year	$51,990,66[illegible]

A slight examination of these figures will serve to show the magnitude of the railway industry. The total assets amount to the enormous sum of nearly eleven billions of dollars and the net income is 455 millions of dollars or enough to pay over 4.2% on the assets.

The following table gives the various figures per mile for each of the last six years:

	1890	1889	1888	1887	1886	1885
Capital stock per mile of completed road	$ 28,333	$ 28,795	$ 28,768	$ 28,321	$ 29,935	$ 29,867
Bonded debt per mile of completed road	31,241	30,178	29,972	28,290	29,062	29,453
"Cost of road and equipment" p. m. of com. rd	53,783	53,740	54,008	52,699	54,901	55,059
Passenger earnings per mile of road in operation	1,732	1,688	1,729	1,756	1,695	1,612
Freight earnings per mile of road in operation	4,686	4,333	4,397	4,649	4,397	4,219
Gross earnings per mile of road in operation	6,875	6,455	6,540	6,861	6,570	6,265
Net traffic earnings per mile of road in operation	2,162	2,068	2.045	2.444	2.376	2,185
Percentage of expenses to earnings	68.54	67.95	68.72	64.45	63.84	65.12
Passenger earnings per passenger train mile	$ 0.920	$ 0 932	$ 0.937	$ 1.008	$ 1.006	$ 0.949
Freight earnings per freight train mile	1.533	1.550	1.557	1.615	1.573	1.518
Gross earnings per revenue train mile	1.368	1.374	1.380	1.445	1.413	1.366
Gross expenses per revenue train mile	0.934	0.934	0.948	0.931	0.921	0.892
Net earnings per revenue train mile	0.434	0.440	0.432	0.514	0.522	0.474
Passenger earnings—proportion of gross	per cent. 25.19	per cent. 26.16	per cent. 26.44	per cent. 25.82	per cent. 25.77	per cent. 26.25
Freight earnings—proportion of gross	68.17	67.13	67.24	68.38	66.94	67 90
Other earnings—proportion of gross	6.64	6.71	6.32	5.80	7.29	5.85
Earnings per passenger per mile	Cents. 2.185	Cents. 2 169	Cents. 2.246	Cents. 2.276	Cen s. 2.181	Cents. 2 198
Earnings per ton per mile	0.935	0.969	0.977	1.034	1.042	1.057
Average distance per passenger	Miles. 24.06	Miles. 24.18	Miles. 24.78	Miles. 24.68	Miles. 25.27	Miles. 25.99
Average haul per ton	112.91	110.92	110 72	111,51	109.49	112.46
Interest per cent. of bonds	per cent. 4.36	per cent. 4.40	per cent. 4.35	per cent. 4.71	per cent. 4.75	per cent. 4.77
Interest per cent. of bonds and debt	4.18	4.09	4.17	4.55	4.53	4.62
Dividends per cent. of stock	1.80	1.81	1.77	2.18	2.04	2.02
Interest and dividends per cent. of stock, bonds and debt	3.03	3.03	3.03	3.40	3.26	3.36

It will be seen from the above that while the capital stock per mile of road shows a constant decrease for the past six years, the bonded debt shows a very heavy increase, a change which it is almost unnecessary to say is not gratifying either from the point of view of good railway management or the public welfare. The passenger and freight earnings per mile of road show a considerable increase for the year and afford an indication of the increase in traffic and economy of operating when considered in connection with the decrease in the earnings per train mile. The average haul shows an increase and the average passenger journey a decrease. The latter is undoubtedly to a large extent due to the increase in suburban and elevated railway traffic. Both the dividend rate and the rate of interest on bonds is seen to be falling.

In connection with the foregoing table the following figures, showing the mileage, gross and net earnings of railways for the last six years, is interesting:

Year.	Road worked.	Gross earnings.	Net earnings.	Gross earnings per mile.	Net earnings per mile.	Interest paid.	Dividends paid.
	Miles.	$ *	$ *	$	$	$ *	$
1885..	123,220	772,568	269,493	6,265	2,185	187,426	77 672
1886..	125,185	829,940	300,603	6,570	2,3.6	189,026	81,654
1887..	137,038	940,150	334,989	6,861	2,444	203,790	91,573
1888..	145,327	960,256	301,631	6,540	2,045	207,124	80,243
1889..	153,7.5	1,002,926	322.122	6,524	2,095	212,974	81,262
1890..	158,057	1,097,847	346,921	6,946	2,195	229,101	83,853

* In thousands of dollars.

It is seen from this that the gross earnings have increased far more rapidly than the net earnings. The fixed charges have also increased faster than the dividends. This is more plainly shown by going back a decade. In 1880 the fixed charges were only 1½ times as large as the dividends, while in 1890 they were nearly 2¾ times as great.

A new feature in this issue of the Manual is a series of very complete tables giving particulars of passenger and freight traffic by groups of states for each year from 1882 to 1890, inclusive. For each group there is given the miles of road included, miles run by passenger trains, number of passengers and number of passenger miles, total earnings, the average receipts per passenger, per passenger mile, per passenger train mile and per mile of railway, the average number of passengers per mile of road and per train mile, and the length of the average passenger journey.

Earnings per passenger mile show very little variation now compared with a few years ago. New England roads earn 1.92 cts. per passenger mile, and roads in the South Atlantic States earn 2.55 cts. Passenger earnings are higher in all parts of the South and Southwest than in any other part of the country.

Annual passenger earnings per mile of road are highest in New England, $4,767 being the average. Roads in the Middle States average about $1,000 per mile less; but the rest of the country shows a far greater decrease, the average being not much over $1,000 per mile, except on the Pacific coast and in the Central Northern States, where $1,850 and $1,490 are the respective averages.

There is of course much less variation in the receipts per passenger train mile. The Pacific Coast roads lead here with $1.33 and New England lines follow with $1.18. Everywhere else the receipts average not more than 80 to 90 cts. per passenger train mile.

Extremes meet also in the average number of passengers per train, New England and the Pacific Coast each averaging about 60. Everywhere else the average is only from 30 to 40. The average passenger journey in New England and the Middle States is only about 16 miles. Everywhere else the average is more than double this, and in the Northwestern States it reaches over 60 miles.

Freight receipts per ton mile are highest in the Pacific States (1.56 cts.), New England (1.37 cts.) and the Southwest (1.35 cts.). They are lowest in the Middle States (0.82 cts.) and the Central Northern States (0.79 cts.). Elsewhere they vary little from one cent per ton mile.

The freight receipts per mile of road are highest by far in the Middle States ($10,845), owing to the traffic of the trunk lines and the coal roads. Roads in the South and Southwest average only $2,800 to $4,000 per mile, and all the rest except the New England roads have to content themselves with $3,000 to $4,500 per mile. The average freight train load as seen by the following table, which covers the freight traffic of the whole country, has had a sudden growth of between 2% and 3%, from 159.91 tons in 1889 to 163.99 tons in 1890.

Year.	Freight Earnings. Av. receipts per ton p. mile.	Av. receipts p. frei't train mile.	Av. receipts per mile of R. R.	Average No. of tons per mile of railroad.	Average No. of ton mile sper freight train mile.	Average haul per ton.
	Cts.	Cts.	$	Tons.	Miles.	Miles.
1882....	1.25	159 21	5,0"4	3,764	128.81	109.02
1883....	1.22	154.09	5,045	3 744	125.86	110.04
1884....	1.12	150.19	4.443	3.526	133.58	112.07
18 5....	1.04	148.91	4,174	3.578	143.59	112 46
1886....	1.04	157.34	4,397	3,853	150.99	109.49
1887....	1.03	161.51	4,647	4,030	156 16	111.51
1888....	0.97	155.71	4,398	4,065	159.36	110 72
1889....	0.97	155.06	4,333	4,029	159.91	110.90
1890....	0.93	153.31	4,687	4,440	163.99	112.91

The following table gives the number of locomotives and cars in use during each of the last six years:

Year.	Locomotive engines.	Revenue Cars. Passenger.	Baggage, mail and express.	Freight.	Total.
1885....	25,937	17,290	6 044	805.519	828,853
1886....	26,415	19,252	6,325	845,914	871.401
1887....	27,643	20,457	6 554	950 887	977,898
1888....	29,398	21,425	6.8"7	1,005,116	1,033,368
1889	31,041	22,885	7,053	1,051,169	1,081,107
1890 ...	32,241	22,958	7,"53	1,061,970	1,092,241

From the table it is seen that, with the exception of freight cars, the increase has remained about constant. This is probably largely due to the delay in handling freight cars, necessitating a larger number in proportion to the traffic than of any other class.

A very interesting table is given showing the comparative mileage of track laid with steel and iron rails, and the percentage of the mileage laid with steel rails to the total mileage of track:

Year.	Miles. Steel rails.	Iron rails.	Total.	P. c. steel of total.
1880	33,680	81,967	115,647	29.1
1881	49,063	81,473	130,536	37.5
1882	66,691	74,269	140,960	47.3
1883	78,491	70,692	149,183	52 7
1884	90,213	66 254	156.497	57 6
1885	98,102	62.495	160.597	61.0
1886	105,724	62,324	168,048	62.9
1887	125,459	59,588	185,047	67.7
1888	138,516	52,981	191.497	72.3
1889	151,723	50,513	202,236	75.0
1890	167,603	40,697	208,303	80.4

The statistics of railway construction for 1890 show a total of 5,738 miles of track laid during the calendar year. This total is practically the same as that shown by our corrected records, which is 5,745 miles, but there are many discrepancies when the mileage is compared by states. As the Manual publishes no detailed list of the track laid it is impossible to tell how these arise, but from the figures presented we are led to believe that the inclusion of lumber and mineral roads and roads used for temporary traffic will largely account for the discrepancy in several states, and there is evidence that in other cases the Manual has neglected to include lines which would properly come under the head of permanent construction.

From the table giving the area, population and railway mileage of the various states it is seen that, neglecting the District of Columbia, Rhode Island has the greatest number of inhabitants per mile of railway, viz., 1,539. Indian Territory, including Oklahoma Territory, leads the other end of the line with a population of 49.05 per mile of road. In case we consider Oklahoma Territory separately from Indian Territory it should receive the latter honor. Nevada and Arizona follow closely with 49.56 and 54.46 inhabitants per mile of railway. On the other hand these two states have the largest area of land, such as it is, per mile of road, viz., 119.9 square miles and 103.2 square miles respectively.

The Manual will be accompanied by two supplementary volumes containing information heretofore

published in the manual itself but which the growing bulk of the volume renders it impossible to publish in this form any longer. These two volumes will be entitled Poor's "Directory of Railway Officials" and "Poor's Handbook of Investment Securities."

Lead and Zinc in the United States.

The lead ores of the Rocky Mountain region all carry gold and silver associated with them, and only a few mines can be classified as lead mines alone. The following table, from Census Bulletin No. 80, gives the summary of lead production in this region for 1889:

States and Territories.	Tons.	Value.
Arizona	3,158	$98,747.84
California	53	1,999.65
Colorado	70,788	2,101,014.31
Idaho	23,172	1,042,629.31
Montana	10,182	456,975.40
Nevada	1,994	72,653 64
New Mexico	4,764	170 754.59
South Dakota	116	4,653 44
Utah	16,675	763 329.09
Totals	130,903	$4,712,757.27

Lead and zinc are produced in the mines of the Mississippi Valley and the Eastern and Southern States, and the source and amount are summarized as follows:

TOTAL PRODUCT OF THE LEAD AND ZINC MINES EAST OF THE ROCKY MOUNTAINS.

STATES.	Total value.	ZINC ORE.		LEAD ORE	
		Short tons.	Value.	Short tons.	Value.
Total.	$4.804 1.9.24	234.503	$3,049,799.25	50,238	$1,754.379.99
Ark	3,650.00	130	3,250.00	20	400.00
Illinois.	4.800 00	.....	.....	173	4.800.00
Iowa ...	3.600 00	450	3,600.00	.....	.....
Kans s	402,428.47	39,575	299.192.05	3,617	103,236 42
Misso'ri	3,59 218.18	93,131	2,024,057 14	44,482	1,571,161.04
N. Mex.	2,520 00	140	2,520.00	.....	.....
Pa. and N. J..	175,052 20	63,339	175,052.20	.....	.....
South'n states..	152,280.00	12,906	141,560.00	268	10,720.00
Wisc'n.	461,630.39	24,832	400,567.86	1,678	64,062.53

Lead smelting and refining are so inextricably mixed, and so often conducted along with the parting of the precious metals, that it is impossible to present tables covering the whole country, though groups of these smelters are given in the bulletin together with output, wages, number of employees, etc. It is interesting to note, however, that in 1825 the total production of lead in the United States was 1,500 short tons; in 1850, 23,500 tons; in 1875, 59,640, and in 1889, 182,967 tons. Of this latter quantity 153,709 tons were desilverized lead, and 29,258 tons non-argentiferous lead.

In 1873 the production of zinc spelter in this country was 7,343 short tons, in 1875 it was 15,833 tons, and it rose quite regularly to 58,860 tons in 1889. Of this later quantity of spelter, Illinois produced 23,860 tons; Kansas came next with 13,658 tons, then Missouri with 11,077 tons, and the Eastern and Southern States with 10,265 tons.

PERSONALS.

Mr. J. B. HOGG has been reappointed City Engineer of Port Townsend, Wash.

Mr. F. B. EMBRICK, an engineer in the employ of the Pennsylvania R.R., died at Devon, Pa., July 31.

Mr. A. R. SHURTLEFF, of Sioux City, Ia., Chief Engineer of the Sioux City & Northern R. R., has resigned.

Mr. J. N. HOPKINS, Superintendent of Water-Works, Richmond, Va., was run over and killed on the railway, July 30.

Col. A. B. ANDREWS, of Raleigh, N. C., has been elected President of the Charlotte, Columbia & Augusta and Greenville & Columbia railways.

Mr. D. B. ROBINSON, General Manager of the Atlantic & Pacific R. R., has resigned to take charge of the San Antonio & Aransas Pass R. R.

Mr. HARVEY MIDDLETON, Superintendent of Machinery, Atchison, Topeka & Santa Fé Ry., has been appointed Superintendent of Construction of the Pullman Palace Car Co., at Pullman, Ill.

COL. SAMUEL H. LOCKETT, now in Bogota, S. A., has published his first report on the proposed change in the water-works of that city. The report is published in *El Correo Nacional*, but agrees substantially with the preliminary plan of works outlined in Col. LOCKETT's letter in our issue of July 18.

Mr. J. LUTHER RINGWALT, of Philadelphia, Pa., editor of the *Railway World*, and author of "The History of the Development of the Transportation Systems of the United States," died recently.

Mr. JAMES R. OGDEN, of Knoxville, Tenn., President of the Knoxville Iron Works, and at one time General Traffic Manager of the East Tennessee, Virginia & Georgia and Memphis & Charleston railways, died last week.

Mr. R. B. CAMPBELL has been appointed General Superintendent of the Ohio division of the Baltimore & Ohio R. R., vice Mr. EDWARD DICKINSON, resigned. Mr. JOHN JOHNSON has been appointed Superintendent of the Akron division.

Mr. RICHARD SMITH, railway contractor, who died at Troy, N. Y., July 30, built the Nickel Plate road from Buffalo to Brocton, and was the promoter of the Cincinnati, Van Wert & Michigan Railroad. He also assisted in the construction of the Chicago & Atlantic.

Mr. FREDERICK H. ROBINSON, Assistant Engineer in the Maintenance of Way Department of the Philadelphia, Wilmington & Baltimore R. R., and formerly City Engineer of Wilmington, Del., has been elected Professor of Civil Engineering of Delaware College, Newark, Del., and Chief of the Engineering Department just established in that institution. Prof. ROBINSON will enter upon his new duties next month.

Mr. GEORGE A. KEEFER, C. E., of Ottawa, Can., has gone to Siberia on behalf of a Canadian syndicate which has been invited by the Russian government to tender for the construction of between 300 and 400 miles of the eastern part of the Siberian railway from the Amur River to Vladivostock, the southernmost point of Siberia, which will be the terminal of the Russian Transcontinental Ry. on the Sea of Japan. Mr. KEEFER was engaged in the construction of the Canadian Pacific Ry. in the mountains of British Columbia.

NEW PUBLICATIONS.

—*Steam Locomotion on Common Roads.* Its history and development. By WILLIAM FLETCHER, M. E. 8vo. 288 pp.; 108 illustrations. 1891. E. & F. N. Spon, publishers.

This is an interesting compilation from many sources of the efforts made to substitute steam power for horses for traction on common roads. While ROGER BACON, 600 years ago, suggested such a machine, few know that the famous Sir ISAAC NEWTON, in 1680, actually described and illustrated a road engine which was supposed to be operated by the reaction of a jet of steam pointing backward. It was, in fact, the æolipile of HERO, of Alexandria; and it is hardly necessary to state never passed beyond the diagram stage of its existence. PAPIN, 1698; SAVERY, ROBINSON, DARWIN, and Dr. SMALL all dreamed of and planned vehicles of this kind before NICHOLAS JOSEPH CUGNOT, in 1763, made the first steam locomotive engine which actually carried passengers on common roads. His machine carried four persons and traveled at the rate of 2¼ miles per hour. It was mounted on three wheels with the leading wheel driven by an engine with two pistons acting upon the wheel alternately. A more powerful machine of the same type, built in 1770, is still preserved in the Conservatoire des Arts et Metiers, in Paris.

The road engines of WILLIAM MURDOCK and WILLIAM SYMINGTON come later, though some writers credit these men with the first introduction of these machines. MURDOCK commenced building his engine in 1781, and he succeeded in making the first successful locomotive in England. It was first tried in 1784. SYMINGTON, whose name figures more prominently in the introduction of the steamboat, devised his steam coach in 1786; and both of these inventors swung their engine between two driving-wheels and used a third wheel as a guide. Our own OLIVER EVANS petitioned the Legislatures of Pennsylvania and Maryland in 1786 to grant him an exclusive right to build steam road carriages; but Pennsylvania quietly ignored the petition which Maryland granted. EVANS never received encouragement and money enough to actually construct his machine until 1805. NATHAN READ, of Warren, Mass., invented the vertical boiler for especial use on steam carriages, and in 1790 obtained a patent for an engine which had two cylinders driving the forward wheels by a rack and pinion movement. Then came TREVETHICK, a pupil of MURDOCK, JOHN STEVENS, of Hoboken, and a host of other inventors, who put forward more or less crude devices to accomplish the end in view.

Some of these were marvelous machines, as, for example, that of DAVID GORDON, who in 1819 proposed compressed air as a motive power for propelling common road locomotives. In 1821 Gordon took out a patent for a small steam engine placed inside a drum 9 ft. in diameter and 5 ft. wide. Inside this drum were spur rings and in these geared the spur-wheels of a regular locomotive steam engine. It was an endless railway in fact, carried with the engine and laid down as wanted. GORDON next tried an engine that poled itself along, so to speak, by a 6 throw crank and toothed feet at the end of hollow tubes. He wasted six or seven years on four engines and then abandoned his schemes. The greatest trouble these early inventors had to deal with seemed to be the utter inefficiency of the boilers. But about 1824-25 Sir I. ANDERSON and W. H. JAMES actually constructed a steam coach that did carry passengers for a while.

The first really successful efforts date from about 1831, when SUMMERS and OGLE built two steam carriages with vertical boilers worked at high pressure, and in a trial attained the extraordinary speed of "32 miles per hour" on a turnpike road. This was down hill, but it was credited with an average speed of 12 miles per hour. Sir GOLDWORTHY GURNEY came next with a very elaborate engine that ran in the neighborhood of London for about 18 months. He ran 84 miles in 10 hours, in one trip, including stoppages. In 1831 Sir CHARLES DANCE ran carriages of GURNEY's make for four months, four times per day, between Gloucester and Cheltenham. During this period he carried 3,000 passengers nearly 4,000 miles. WALTER HANCOK, of Stratford, London, was the most successful of all steam-carriage schemers. He experimented during 16 years, built 10 excellent carriages, and was the only one who ran a locomotive through the most crowded streets in London. His machine was noiseless and could travel at the rate of 15 miles per hour. He abandoned the scheme as unprofitable about 1840.

This interesting work of Mr. FLETCHER carries this seemingly exhaustive history of road locomotives on into modern times, and concludes with a similar historical sketch of traction engines. It is a valuable addition to engineering literature on a subject heretofore scattered through all manner of obscure and practically inaccessible books and publications.

—*The Logarithmic Spiral Curve.* By Wm. COX. New York: Keuffel & Esser Co. Pamphlet, 8vo., pp. 8; 3 cuts. Twenty cents.

Contributions on mechanical methods of computation by Mr. WM. COX have appeared from time to time in ENGINEERING NEWS and this pamphlet treats of a branch of the same subject. As we shall shortly publish an article on this curve, also written by Mr. COX, we will not review this very valuable little work farther at present.

—*Electricity.*—Chicago. Electricity Newspaper Co., 307-8 Temple Court Building. J. W. Dickerson, Editor. Subscription, $2.50.

This is a new weekly journal devoted to the science covered by its title and having Chicago as its headquarters. The first number is dated July 22, and, if succeeding numbers compare with this in excellence and profusion of illustrations, typography and its general selection and arrangement of matter, it will get on. The aim of the editors is evidently to introduce more popular matter in this branch of science than is usual among electrical journals.

—*Retaining Walls for Earth.*—Including the theory of earth pressure as developed from the ellipse of stress. With an appendix presenting the theory of Prof. WEYRAUCH. By MALVERD A. HOWE, C. E., Professor of Civil Engineering Rose Polytechnic Institute. Second edition, revised and enlarged. John Wiley & Sons, publishers. New York, 1891. Small 8vo, with illustrations, 136 pp. Price, $1.25.

—*Car Lubrication.*—By A. E. HALL, B. S., M. E. John Wiley & Sons, publishers. New York, 1891. 12mo, 66 pp., with illustrations. Price, $1.

A very useful book on a subject upon which literature is very scarce. While the author gives full credit to Prof. THURSTON and to Mr. WOODBURY for their researches in this direction, he puts the various theories and results of experiment in a very practical shape and shorn of all but the plainest mathematical dress. The volume is evidently the work of a practical investigator and is correspondingly valuable.

—*The Compass.*—A monthly journal for engineers, surveyors, architects, draftsmen and students. 8vo, 16 pp., with illustrations. WILLIAM COX, editor; Keuffel & Esser, 127 Fulton St., New York, publishers. Subscription, $2 per year.

This is a very handsomely printed and well-illustrated monthly, with a page about the size of *Harper's*. As may be expected from its title, it is especially devoted to the practical explanation and exhibit of new instruments and methods in surveying. While this is the first number, and it is too early to pass judgment, the evident intention of its editor and publishers is to make a journal useful to a wide class of readers.

SOCIETY PROCEEDINGS.

The American Association for the Advancement of Science will hold its 40th meeting at Washington, D. C., beginning Aug. 17. The hotel headquarters will be the Arlington, near the Columbian University, where the meetings will be held. A circular of 24 pages setting forth the full program can be obtained by addressing F. W. Putnam, Permanent Secretary, Salem, Mass., or Marcus Baker, Local Secretary, U. S. Geological Survey, Washington, D. C.

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AND

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GEO. H. FROST.....BUSINESS MANAGER

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July 4, 1891.

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COMING TECHNICAL MEETINGS.

Engineers' Club of Kansas City.—Aug. 10. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—Aug. 11. Secy., Parker N. Black, Room 39 Capitol Block.

Civil Engineers' Club of Cleveland.—Aug. 11. Secy., A. H. Porter, 50 Euclid Ave.

Denver Society of Civil Engineers.—Aug. 11. "Sewer Construction." Secy., Geo. H. Angell.

Civil Engineers' Association of Kansas.—Aug. 12. Secy., J. C. Herring. Wichita, Kan.

Engineers' Society of Western Pennsylvania.—Aug. 18. Secy., J. H. Harlow, Pittsburg, Pa.

Engineers' Club of Cincinnati.—Aug. 20. Secy., J. F. Wilson.

Scandinavian Engineering Society of Chicago.—Aug. 20. Secy., T. G. Philfeldt, 118 Adams St.

Engineers' Club of St. Louis.—Sept. 2. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

Western Society of Engineers.—Sept. 2. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of Minneapolis.—Sept. 3 Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—Sept. 4. Secy., E. K. Smoot, 803 Commerce St.

Technical Society of the Pacific Coast. Sept. 4. Secy., O. von Geldern, 819 Market St., San Francisco.

American Society of Swedish Engineers.—Sept. 5. At 250 Union St., Brooklyn, and 347 North 9th St., Philadelphia.

Civil Engineers' Society of St. Paul.—Sept. Secy., C. L. Annan.

OUR knowledge of the behavior of American timber under stress is based upon very incomplete and antiquated series of tests, and until very recently no attempts have been made to supply a want so keenly felt by every engineer and architect who has to deal with wooden construction. The rules of GORDON and HODGKINSON, as applied to wooden pillars, are very old; Mr. TRAUTWINE has done some good work, but his experiments are confined practically to pine, and CHARLES SHALER SMITH, in his excellent formula for the breaking load of square or rectangular pillars, also limited his experiments to white and yellow pine. Mr. KIRKALDY has tested long pillars of Riga and Dantzic fir; and other scattered data, of more or less value, are to be found. But the first exhaustive series of tests of American woods ever attempted is now in progress at the testing laboratory of the Washington University, as directed by Prof. J. B. JOHNSON, and detailed by him elsewhere in this issue. These tests are being made under the auspices of the Forestry Division of the U. S. Agricultural Department, and Mr. B. E. FERNOW, the Chief of the Forestry Division, is deserving of much credit for thus supplementing his previous good work in treating of the timbers of the United States. The vast extent of our forests and the great variety of useful timber at our command make it especially necessary that we should know all about their life and behavior in service; and while these tests, to be valuable and exhaustive, necessitate the expenditure of both time and money, it is to be hoped that the good work will be continued with no stint in the appropriations therefor. To obtain these exceedingly valuable data, almost any expenditure is warranted, and our public departments can do no better work than in continuing to spread eminently practical information of this character. The Forestry Division is deserving of the thanks of the whole engineering and building fraternity for the useful work it has so well commenced, and it should have the vigorous support of every one interested in supplying material and information, and, if necessary, in seeing to it that the means are not wanting to carry out these experiments to their legitimate end. It is one of the most valuable series of tests ever commenced by our government.

THE paper of the Messrs. ATKINSON on electrical mining machinery, given elsewhere in abstract, contains matter of much interest on a subject of comparatively recent but rapid growth. Few if any progressive mine operators now doubt the adaptability of electricity to all manner of mining operations, or the facility with which it can be led into intricate underground workings, as compared with any system of piping. The one doubtful, and a most important, point is whether or not it can be used with safety under the conditions present in an average coal mine operated by men unskilled in the use of electricity. The Messrs. ATKINSON think all danger can be avoided, and back their statement by an experience of four years with this particular class of machinery. Though Sir JOHN COODE, President of the Institute of Civil Engineers, hoped at the outset that the question of the safety of electric power in coal mines, as compared with other methods of conveying power, should occupy a prominent part in the discussion of this paper, no one speaker, in the very voluminous discussion that followed, denied that, with the motor protected and reasonable precautions taken in ventilation, there was little or no danger to be apprehended from the use of electricity. The bulk of the discussion turned on the relative economy of electricity vs. compressed air, rather than upon the question of their relative safety. As far as this discussion treated of the subject, electricity seemed to have the best of the argument on the score of economy in power and less loss in transmission. But it is also evident that the introduction of the new power into the market was having the effect of making manufacturers of compressing machinery study more closely the working of their own machines. There is no doubt that air compressors can be still further improved, great as has been the progress in late years. In the Popp experiments in Paris the absence of perfect cooling of the compressed air resulted in a loss of 40% of the gross power, and Mr. HOWARD D. PEARSALL claimed that if he could eliminate this loss all other losses would amount to only 33%, leaving 67% net efficiency. Again, for use in motors, there is great advantage in heating and expanding the air before it enters the cylinder; and while this has been done by Mr. FREDERICK HURD in a mine motor, and by Mr. MEKARSKI in his tramway engine, both systems can be and doubtless will be improved upon and made more valuable commercially. In fact, in mining operations, as in other fields, the electric motor is there to stay, and the appearance of this new power will have the usual stimulating effect upon any rival power that has hitherto held the field undisputed, and we may expect advance in old methods to meet the new conditions.

WE regret to say that after all and notwithstanding the vigorous efforts of the engineer and all connected with the construction of the Chignecto Ship Railway, in New Brunswick, work was shut down on July 31, until next spring, under orders from England. The Argentine troubles and the general financial distress in London have been too much for the promoters of this project and they must await a better money market. Efforts are being made, however, to continue work on the Amherst lifting dock; two months' work would finish it, as the gridiron and lifting machinery are on the ground and the boilers, engines, pumps, etc., are set up ready for steam. The whole ship railway is four-fifths done, and the present suspension is thus especially unfortunate, at a time when the whole engineering world looked forward to a practical demonstration of a new engineering device for the transfer of ships between neighboring seas. While we have no authority for saying so, it might be timely for some enterprising Yankee capitalists to step in and at least share with England and Canada the honor of constructing the first ship railway of modern times. Under present conditions they could doubtless make very excellent terms.

THE communication of Mr. PURDY describing the theory and practice of the compound foundation of concrete and iron, now so popular in Chicago, is most interesting. As he explains, this novel departure took its origin in the serious settlement and failure of several public buildings in that city erected upon pile foundations in the treacherous soil underlying Chicago. The credit of the introduction of isolated pier foundations on compressible soil as opposed to pile foundations, is usually ascribed to Mr. FREDERICK BAUMAN, an architect of Chicago, and the efforts of other architects to economize material and secure more basement space finally lead to the development of the type of foundation described in Mr. PURDY's paper. Many of the famous high buildings of Chicago, including the Rookery, Auditorium, Tacoma, Manhattan, Monadnock, Owings and Phœnix buildings, are so founded, and these foundations have all, as we understand, most successfully met the demands put upon them in distributing the weight of these high and heavy structures. While Chicago is peculiar among the great cities of the North in the unreliable nature of its subsoil, the principle involved in these compound foundation is applicable to many other locations and special types of construction, as is pointed out in the concluding part of the paper. The great merit of the combination of beams and concrete is the securing of transverse strength in the founda-

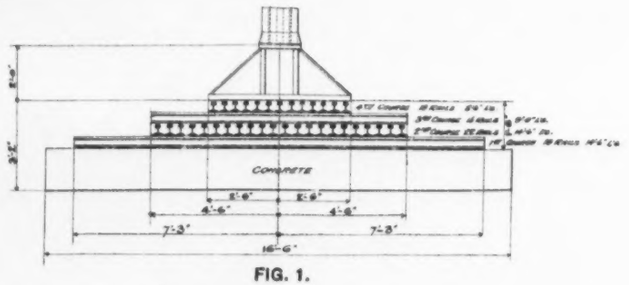


FIG. 1.

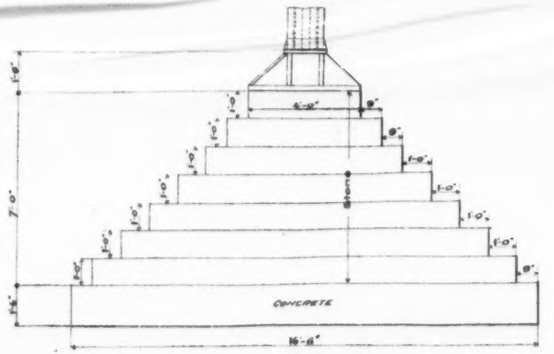
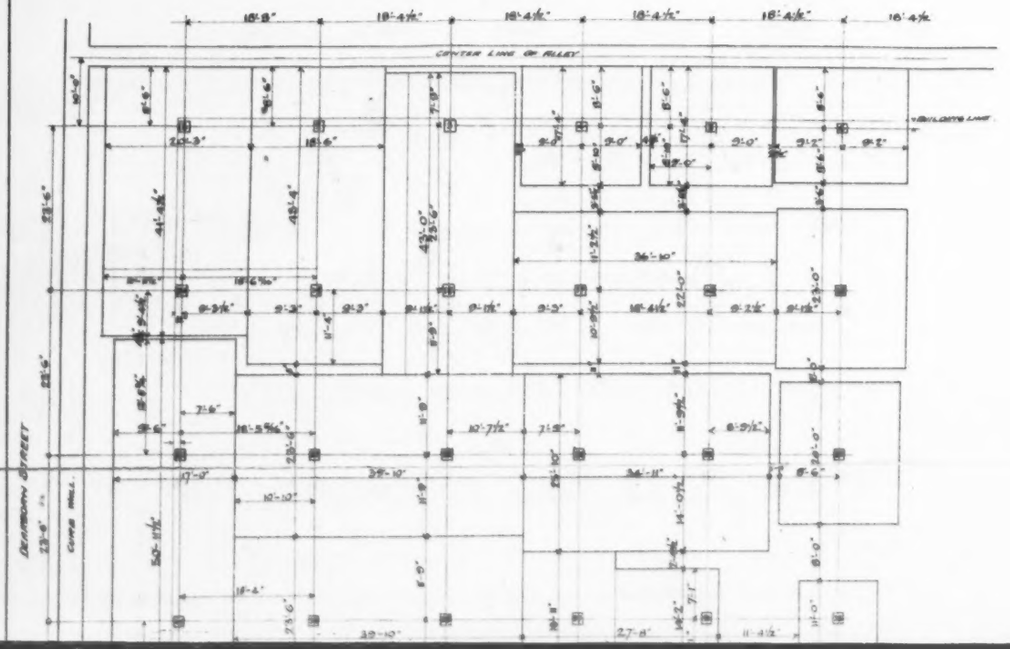
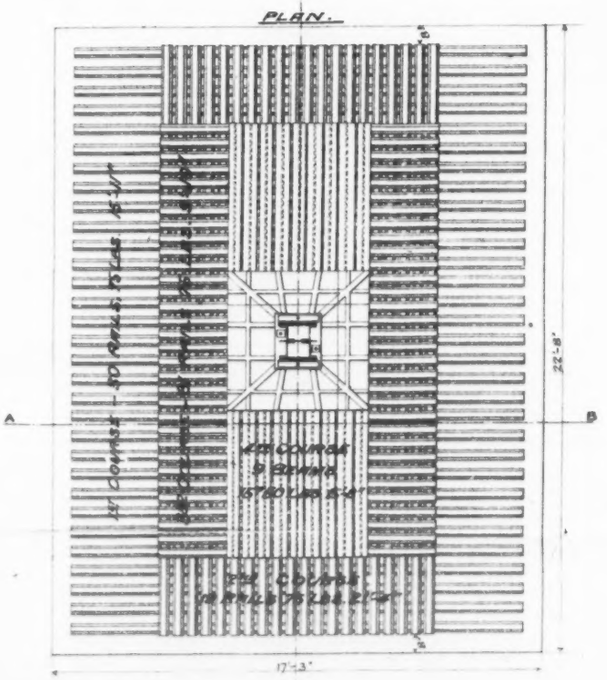


FIG. 2.

COMPARATIVE SECTIONS OF STEEL AND STONE FOUNDATIONS.





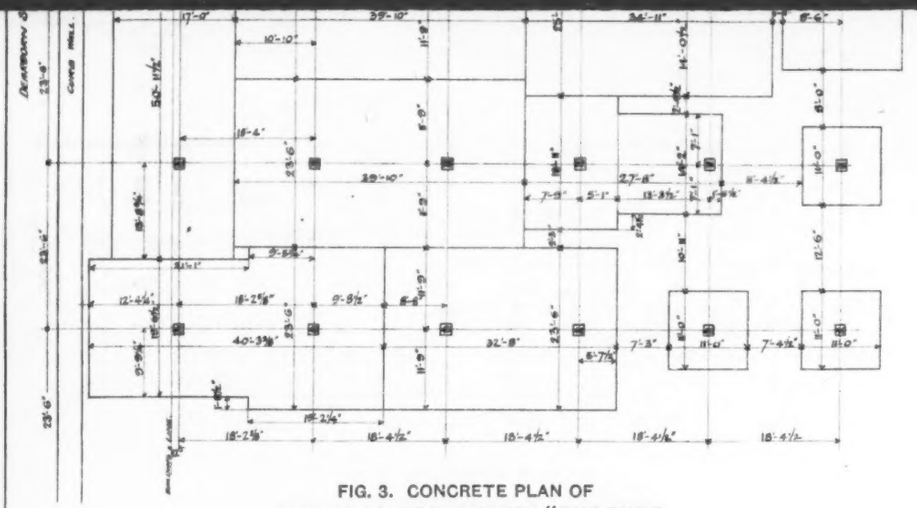


FIG. 3. CONCRETE PLAN OF
PART OF FOUNDATIONS FOR "THE FAIR."

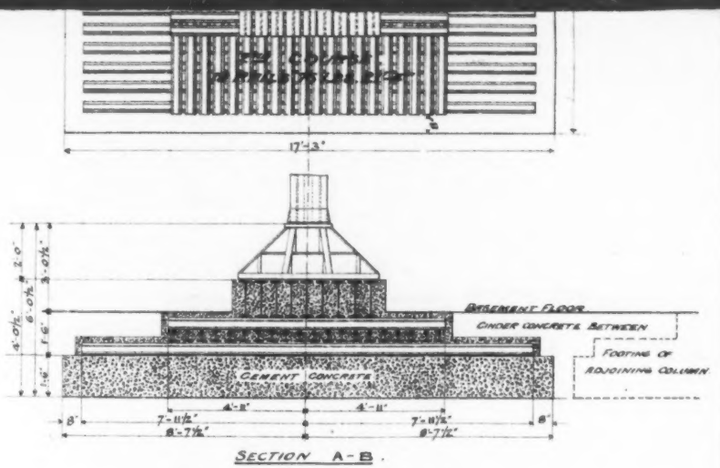


FIG. 4. DETAIL ARRANGEMENT OF
STEEL BEAMS AND RAILS FOR FOUNDATION OF COLUMN.

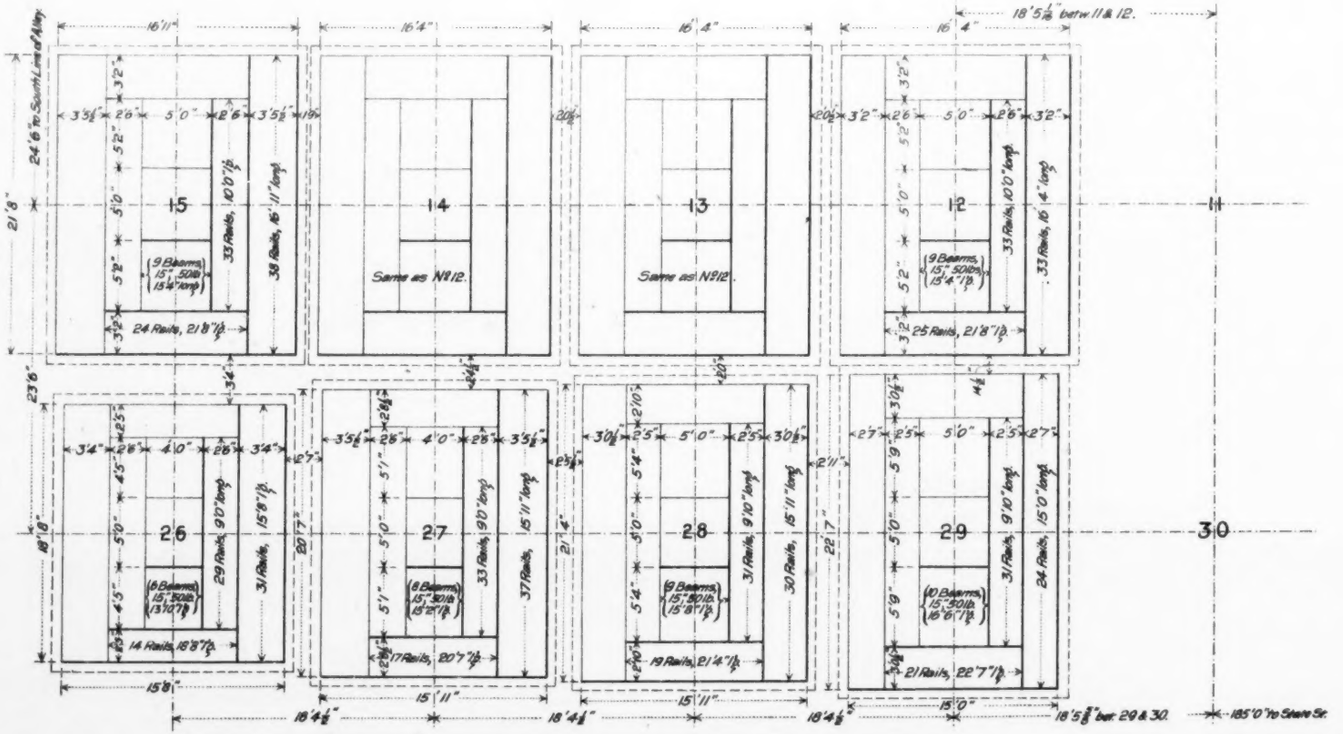


FIG. 5. GENERAL WORKING PLAN OF ARRANGEMENT OF BEAMS AND RAILS.

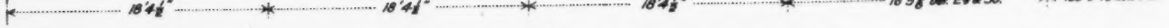


FIG. 5. GENERAL WORKING PLAN OF ARRANGEMENT OF BEAMS AND RAILS.

STEEL RAIL FOUNDATIONS,
AS USED IN "THE FAIR" BUILDING, CHICAGO.

W. L. B. JENNEY, ARCHITECT. GEO. A. FULLER & CO., CONTRACTORS.

CHAS. HART & SONS, LITH., 24 VESEY STREET, N. Y.

tion without resorting to an abnormal thickness of concrete, as would be the case were concrete alone depended upon. The failure of the City Hall in Chicago, which settled unequally as much as 14 ins., was due to the fact that the underlying bed of concrete was too thin, and by the unequal resistance of the underlying clay it was called upon to perform the office of a beam, a duty it was not proportioned to perform. The general merits of the system here described need not be pointed out further to engineers; nor need engineers be warned that judgment must be used in its application, and that experience and technical knowledge and care are as essential to its successful use as in any other equally important branch of architectural engineering.

As might be expected this radical departure from long-received methods of foundation building has aroused discussion among architects, especially in Chicago, and the advocates of piling methods are not silent. One of the ablest of these last, Mr. DANKMAR ADLER, has contributed a seasonable article on this subject to *The Economist*, of Chicago, and in a sound argument defends the use of piles, and ascribes the failure of this class of foundations in Chicago, not to the use of piles, but to their abuse and lack of care and sufficient knowledge in their application. He cites the enormous grain elevators of that city as examples of what can be successfully accomplished with a judicious use of piles, and truly says that the unequal and constantly shifting load in these structures is a severer test upon the foundation than the dead static load of a 20-story building. We agree with Mr. ADLER to the extent that when piles are properly spaced for the load to be imposed, and driven to a firm and unyielding stratum, the system is one of the safest, as it is practically the oldest, of all forms of foundations. In the hands of men like himself, thoroughly experienced in all the vagaries of Chicago soil, his judgment and knowledge are factors of safety in themselves, and his foundations may doubtless be relied upon. But no engineer knows better than himself of the influence of the uncertainty of the soil on pile driving, and of the many good works that have failed purely from the development of totally unexpected trouble in this direction.

We have ourselves a lively recollection of founding an expensive work upon a subsoil made up of alternating and unknown strata of mud, clay and streaks of very hard gravel of varying thickness. Circumstances forbade the proper preliminary examination of this soil, and the only guiding rule was to drive the piles until their resistance was such as to warrant imposing certain loads upon them. In one case, these piles performed their duty for a period of years, and then began slowly to sink and ultimately wrecked a part of the structure. It was found later that some of the piles had penetrated half way into a hard crust of gravel, with a resistance to driving that indicated very hard bottom. Though no load was added to the structure itself, the frictional resistance was gradually reduced from some cause, and at the end of 7 years the piles broke through the bottom half of the hard crust and sank into an underlying stratum of soft mud, with the result given. Here was a case where a well-knit compound foundation would have been safer and more certain in distributing the whole load over a wide area rather than concentrating it upon the points of a few piles. For other sites piling is wholly unreliable, and New Orleans has a sub-soil notably of this class. There the alluvial deposit is literally of unknown depth, and though the utmost care was displayed years ago in providing a concrete base for the Custom-House in that city, the settlement was very uneven and the roof-line undulates like the waves of the sea. For our own part we would favor treating the whole building as much as possible as a single pier rather than depending too much upon an isolated pier construction for the several parts of the building. Of course there is a limit to this treatment, and it is practically impossible in a very large area of foundation. But even in the latter case the introduction of beams into the concrete, as here indicated, adds a most important element of transverse strength, that makes their use economical and advisable.

The Mœnchenstein Bridge Disaster.

We gave last week in another column as full information as it was possible to obtain in regard to this terrible disaster, which ranks among the three or four greatest bridge disasters on record. In fact, we recall only two others which both in nature and magnitude are comparable with this, the Tay bridge disaster in Great Britain and the Ashtabula disaster in America. In each of these the primary cause of accident was bad design of an iron bridge, due to ignorance in the designing engineer. In the case of the Ashtabula bridge these defects were measurably pardonable as occurring in the infancy of the art of iron bridge building, and primarily chargeable, moreover, not to an engineer, but to a too-knowing bridge contractor, who, having built many miles of wooden bridges with success and large profits, thought he could build iron bridges also in the same style and with the same success, and so usurped the functions of an engineer. The Tay bridge disaster was of a much less pardonable nature, as resulting from errors of an engineer of long experience and high reputation, assisted by a large staff, in designing a structure of such magnitude as to give every reason for great caution, and every chance for it.

Except in the one item of magnitude, the same was true of the Mönchenstein bridge. An engineer who was even then, and still more now, of world-wide fame, M. EIFFEL, built the bridge and at least made himself responsible for the design by signing the plans, if, indeed, he did not himself design the details. While final judgment should not be expressed until after the appearance of the official reports of the disaster (a year or so hence, perhaps) it seems to us clear that a considerable part of the responsibility, at least, lies with M. EIFFEL or his assistants. It is also entirely clear, as shown more fully elsewhere, that the Mönchenstein bridge, like the two others mentioned, fell from inherent weakness only, without any adventitious cause like derailment to add to the normal strains. Even had there been any derailment, as we have often said before, it would have been no excuse for the disaster, since it is perfectly easy to so design the floor that any ordinary derailment shall not produce destructive strains, and no bridge should be so designed that it becomes unsafe if derailed wheels run onto it. But until human nature has been made over, derailment will be accepted as a certain *quasi* excuse for such disasters, and therefore it is in a sense fortunate that there was no such occurrence to obstruct comparison and diminish the force conveyed by the disaster.

The three disasters which we have mentioned compare in their main details as follows:

	Span ft.	Date of Erection.	Date of Fall.	Ht. above stream.	No. killed.	Persons injured.	Passrs. on train.
Ashtabula	157	1861	Dec. 29, 1876	75	92	.....	158
Tay	245	1877	Dec. 28, 1879	88	86	0	86
Mönchenstein.	135	1874	June 14, 1891	15	74	200	500

It will be seen at once that while the first on the list belonged to the infancy of iron bridges, the two last were designed and erected much later. It must be to Americans a source of solid satisfaction that the only two bridge disasters since the Ashtabula which are at all comparable with it have both occurred in Europe, and under much less excusable circumstances than the Ashtabula.

Nevertheless, with that very human weakness of which the Biblical Pharisee is the immortal type, the Swiss and other European journals began to declare with one voice, soon after the disaster, that now at least they had an accident *à l'Américaine*, and the impression is far too deeply seated abroad for this journal to shake it, that, whereas such occurrences were very rare in Europe, they are very common in America! What we have said elsewhere and have yet to say in regard to the absurd inefficiency shown in clearing away the wreck will strengthen this impression. They will declare—those of them who do us the honor to read these words—"Naturally the Americans have more skill than we in reopening the track after accidents; they have more practice. What with us is rare is with them almost an every-day matter. However much they may deny it, the very fact that they have the skill and the appliances at hand for clearing the track quickly, shows it to be an every-day matter with them."

Be this as it may (we will not stop to dispute the matter, nor point out the reasons why this argument is wholly unsound), it is evident that in *military* railway work, frequent accidents and intentional destructions are to be expected, and that it is to the last degree most important that the nation which does not wish to be left hopelessly in the lurch must be at least as skillful as its opponents in reopening track over wrecks quickly in war times, and as much more so as possible, and it is upon this aspect of the disaster that we propose to comment chiefly. Until the official report of the disaster appears, it is useless to discuss in much detail the technical features of the structure.

The circumstances are these: Europe is at this moment an armed camp, with France and Germany leading the two groups of nations into which all Europe is now supposed to be divided. To an extent which it is quite impossible for us to realize in America, the thought and the fear of war controls and pervades the daily life of the leading European nations. The impression that war on a gigantic scale cannot fail to break out within a score or two (or may be three) of months is all but universal, and governs the whole policy of Europe in regard to railways, and everything else having possible relation to the efficient carrying on of war.

Now, it will not be denied or questioned that even in Europe, with its shorter distances, the maintenance of unbroken railway connections between the armies in the field and the remoter bases of supplies is a delicate and difficult problem, while absolutely necessary to warfare on equal terms. Let France maintain its own and cut the German railways even for a few days, or let Germany do the same against France, and the side without railways would be at a disadvantage which would be very likely to be decisive. Therefore it behooves each of them not to fall very far below the attainable maximum of efficiency in such work, which, it will hardly be disputed, has been shown in American practice. If there be not the same necessity for very long railways between armies and bases of supplies as there was in our war, there is, on the other hand, nothing like such great distances and such bad roads to get over to cut them.

This being so, what does the Mönchenstein disaster indicate as to the capabilities of the future combatants in this most vital of all elements of military efficiency? It occurred neither in France or Germany, but in Switzerland, a probable neutral, and hence does not directly indicate anything; but, on the other hand, it occurred within a few miles of the frontier of both those countries on a line which has very close traffic arrangements with each, and within easy reach of such

facilities as either country might have for quickly handling such a wreck, if they have any. So far as pretty close observation of the surface indications go, the Swiss railways are neither better nor worse in their management and their preparation for unexpected and unfortunate events than the French or German. Had the military authorities of either of those countries been alive to the importance of being prepared for "military railroading," and been prepared with the necessary plant, we may be tolerably sure that they would not have lost such an opportunity to tender its use to the Swiss, and so quietly observe what it was capable of under the guise of doing a neighborly act. Therefore it appears not unreasonable to infer that what was actually done on the Swiss frontier was a pretty fair index of what would occur in a similar case in either France or Germany.

If so, the circumstances are full of instruction and warning to the future combatants. This insignificant little single-track bridge, 135 ft. span and about 15 ft. above water some 4 ft deep, with a solid gravelly bottom, fell June 14. The *débris* were not fully removed from the bed of the stream until July 1, 16 days later, *and the temporary track and bridge were not completed until July* 16, *over a month after the disaster occurred*, and this on one of the most important passenger lines in Europe, at the very opening of the season of heavy travel!

We risk nothing in saying that under similar circumstances on any line in the United States the bed of the stream would have been cleared and the temporary line would have been opened for traffic within three days after the disaster, and the permanent bridge re-erected within about a month. Why? Not because our railways are in the habit of having such accidents as this often; on the contrary, as we have already noted, they have never had a single accident so entirely inexcusable as this one appears to be; but because they *are* equipped with portable derricks and pile drivers adequate either for rapid new construction or for any accidental emergency which may arise, and have also (what is more important) men trained to the effective use of the plant, in the quick construction or renewal of any track which may be required for sidings or branch lines, or which may have been injured by storms or washouts, from whom and from similar employees of the mechanical department, organized "wrecking gangs" are formed and kept in a state of efficiency for dealing with any emergency.

Such a staff would have made short work with the Mönchenstein wreck and resulting break in the track. There was really little to do to reopen the line; 10 bents of pile trestling, four piles per tent, would have carried the temporary track well over the water, and then all that remained to do was to throw up 100 ft. or so of embankment about 10 ft. high at each end of this trestling, or (what would more probably be done) trestle over the entire distance, the track being in perfect order up to (and including) the abutments. Under these circumstances, what would still more probably have been done on an American line would be, to build no temporary line at all, but to immediately clear the bed of the stream with derricks capable of lifting a locomotive bodily, or at least of sliding it up a timber incline, and in the meantime, to have the piles all at hand, and the timber flooring for the trestle all framed, ready to temporarily trestle over the gap in the permanent line, all of which would easily be done by most railways in three days, even in peace times, and give as solid and as safe a track as existed before, so long as the timber continued sound.

As for what would probably be done in time of war times, we need only refer to Gen. HAUPT'S excellent history of the "Military Railways of the United States" in our civil war. We subjoin in a foot note below a few of the remarkable feats therein recorded, with which we will not encumber this article,* but we think it a perfectly fair inference from what was done then that a corps of trained men such as then existed and might now be readily improvised from our American railway staffs would have reopened this track in war times in a few hours instead of days.

Instead of this, we find that weeks, instead of days or hours, were required to clear away the wreck, not to speak of reopening the track. Are any of the great powers of Europe, with their hundreds of thousands of troops under arms, prepared to do much better? If not, what will become of their armies if their enemy should be wise enough to be thus prepared in advance, while they have not been? It appears to us a certainty that, great as is the importance of superior generalship, the combatant in the next great war who was provided with a military railway staff such as we had in our war, and also with a few dashing cavalry officers who would cut loose from their base with a few hundred men, and strike for the enemy's railway communications, even at the risk of being taken prisoners soon after, would have an advantage which no generalship could counterbalance.

It is true that it is much easier to defend the European railway communications than it was our own, because the distances are shorter and the armies instantly available larger; but on the other hand, the short distances make it easier to attack the railways as well as to defend them. There are also far more tunnels and large masonry structures which by their destruction would block the lines. Which is the European power which is prepared in case of need to throw a temporary line with curves of 50 to 100 ft. radius around a blown-up tunnel, and has the men who know how to do this and then operate the track successfully with its ordinary rolling stock so successfully as to supply a large army for months over a single track of this kind, as was done in our war?

The side which is prepared to do this will surely have a vast advantage over the side which is not, and it is to be remembered also that no long notice of the breaking out of war is needed or probable. It might well be that the first notice will be a raiding party to break railway communications. It is to be remembered also that, while the frontiers are in general so strongly fortified as to be quite impassable for a large army, which must keep open its base without first besieging them, a few hundred or thousand men can break through anywhere by cutting loose from any base; and once away from the frontier can by good leadership count on a few days' freedom before they are surrounded and captured. Now, the entire length of the German-French frontier from Switzerland to Holland is under 300 miles, or about the distance from Pittsburg to Louisville. What destruction of communications could not a few thousand men, mounted on fleet horses and led by fearless and dashing officers, effect in a little distance like this before they could be surrounded and captured? That destruction once made, how long would it take to repair the damage, to judge by the Swiss example?

Again, besides the damage which organized troops in uniform might effect by a raid, running no other risk than of being taken prisoners of war, no great people has ever lacked devoted men who will brave a spy's death to render their country a great service. It is not for us to specify just how and where they might do this by destroying important railway structures, but we are convinced that, were it the duty of American military men to be prepared for offense and defense against any of the European nations (as it fortunately is not) they would conclude that the maintenance of their railway communications was their most reliable point; and had they the skill and the men which they had at the end of our "late unpleasantness" they would stand an excellent chance of striking a crushing blow against any one of the present European powers at the very outbreak of hostilities. Moreover, were it our unhappy lot to have to keep on a war footing all the time, as do the European nations, this department, of all others, would be the one which American military men would feel bound to keep constantly up to the highest point of efficiency, or we greatly mistake them.

Passing from the military aspect of this disaster, there is one other which demands brief comment—the extraordinary way in which *seven* successive carriages were piled up in a mass of kindling wood and scrap in the short space of 50 ft., with a fall of only 15 ft. Not until the eighth car reached the brink did there prove to be a big enough heap of wreckage in front of it to "hang" it on the abutment. These 7 vehicles had a total length of nearly 300 ft., as shown in the detail given last week, and to heap these together in a single pile of wreckage was made possible only by three causes which are peculiar to European rolling stock, viz.: (1) The frail nature of the couplings and buffers, which are very readily upturned as soon as the "axiality" of the train is disturbed; (2) the shortness of the cars, and (3) the frail nature of the upper works. Unfortunately our own couplings do not hold the car platforms indissolubly together in the same horizontal plane, with the sole exception of the little-used Blackstone type once employed on the Chicago & Alton Railway, and many accidents otherwise avoidable have happened in consequence; but compared with any coupling to be seen on any European railway, they are very rigid and strong, and we think that no one can look at the photographs of the disaster, remembering also the slow speed at which the train was moving, without reaching the conviction that, at the slow speed at which the train was running, not more than one car at most would have upturned its coupling and fallen into the gap, and that the second car at least would have been "hung" on the abutment and prevented any further wreckage and loss of life. As these first and second cars would have been baggage and express cars, the total loss of life must necessarily have been small in that case.

The Swiss rolling stock is described in Baedeker's guidebooks as "of the American type," and so it is in the one particular of having a sort of passageway through each car so that it is *possible* (although so dangerous that no passenger is prone to attempt it) to walk through the whole length of the train; but in every other respect the Swiss rolling stock is as different from the "American type" as can well be imagined, and substantially similar to other European rolling stock. The cars are very short, and the platforms at least 4 ft. apart in the clear, instead of about as many inches. The spring buffers, instead of being firmly built into the framework of the car, are merely bolted on the endplate of the platform, and incapable of resisting any considerable strain except one which is exactly parallel with the rails. The great space between the platforms is partially bridged over by

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* While Gen. HAUPT enters fully into the detail of the construction of military bridges he does not give many examples of actual construction and the time consumed therein. He does describe, however, one remarkable trestle bridge built by him over the Potomac River. This bridge was 400 ft. long, 80 ft. high and contained about 2,000,000 ft. B. M. It was built by the soldiers in 9 days, and over it Maj. Gen. McDOWELL passed his whole army with its artillery and baggage trains. A very high railway bridge near Atlanta, Ga., was burned by the Confederate troops and rebuilt by SHERMAN'S soldiers in 3 days, with round logs cut from the woods near by. Other examples are numerous, but unfortunately this branch of the military engineering of our late war has not been made generally accessible.

But a more marvelous record still, in rapid bridge building, was made in replacing, in time of peace, the great Portage bridge, in New York State, burned down May 6, 1875. This structure spans the Genesee River and is 800 ft. long and 234 ft. high from rail to water level. The original bridge was wood, but by May 10, 1875, plans had been made for an iron truss on iron piers resting on the low stone piers of the old structure, and the bridge contract was let on that day to the Watson Manufacturing Co. On June 14 the first column was raised, and on July 31, 1875, or in just *forty-two working days*, the bridge was finished and thrown open to traffic. The total weight of iron in the bridge was 1,300,000 lbs. This bridge was a double-track structure on the line of the New York, Lake Erie & Western Ry., and the topography forbade any temporary crossing.

a light projecting cast-iron plate. The coupling is by a right-and-left screw, the precise size of which we cannot give, but which certainly has not much over half the strength against a sudden pull or shock of the ordinary American freight link. Taken altogether, only a photograph (which we hope to secure and engrave shortly) can do justice to the gawky outwardness of this coupling gear in American eyes. It goes far to explain the antipathy of European engineers to curvature. Such coupling gear is only fitted for rectilinear motion, and even a slight angle of obliquity places it in great danger. In a case like that at Mönchenstein, where there is a yawning gap to fall into, the mechanical conditions are practically the same as if the successive cars were entirely disconnected from each other, and simply pushed forward from behind. In such circumstances it naturally requires a pretty large heap of wreckage in front of the abutment to prevent each successive vehicle from jumping over it into the abyss.

CORRESPONDENCE.

A Correction.

DENVER, COL., July 28, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: A letter appeared in ENGINEERING NEWS of July 25, 1891, from MR. JABEZ STONE, headed "Quick Work." I desire to make a correction. The letter is in substance correct, with the exception of time consumed; instead of *two weeks*, it should read four days. The work was commenced the morning of April 27th and completed at midnight of April 30th.

W. F. MCCUE,
Superintendent American Water-Works Co.

[The work referred to consisted of the digging of a 4½ ft.-trench and laying five miles of 6 to 16-in. pipe, and, in another part of the city, setting 62 valves and 248 hydrants on some old pipe.—ED. ENG-NEWS.]

The Moenchenstein Truss.

PITTSBURG, Pa., Aug. 4, 1891.

TO THE EDITOR ENGINEERING NEWS:

SIR: From the description and plans given in your last issue of the Moenchenstein Bridge, it would appear that its failure must be ascribed primarily to the absence of any portal bracing, a quite common defect of older iron through bridges.

There were sure enough numerous other defects of detail, to judge from the plans, but none so fatal as the absence of the portal bracing, and it was the more fatal for the bridge being on a skew. It would appear that recently the traffic over the road had been heavier than before, causing, in all probability, low and jarring rail joints on the bridge.

Locomotives on a bad track produce violent lateral blows. This is aggravated by low rail joints. There was no provision in the bridge for transmitting the violent lateral motion in the top bracing to the abutments and no provision against lateral deformation of the structure. A sharp blow from the driving wheels at one or two low rail joints, a violent shaking up of the structure, a snapping of the connection of the top strut to the inclined post, which was the weakest point, and the bridge would slowly turn and collapse, precisely as this one did.

The photographs of the wreck show that the bridge, in spite of the defective details, did not fail in the truss connections or members. To use a simile: An apple tree may have strong enough connections of apples to boughs to resist the swaying of ordinary winds, but a sharp shake from a boy will break this connection and bring the apples down. Likewise the sharp shake from two locomotives snapped in all probability the end connection of the top bracing that had withstood, but may have been weakened by the swaying of the last 16 years.

In this connection I would call to remembrance that the most credited cause of the failure of the Ashtabula Bridge, 15 years ago, was also the fracture of the very weak connections of the lateral cross-bracing between the trusses, in that case from the combined effect of two locomotives and a heavy gale blowing square across the bridge. It is most remarkable that no portal bracing was put in the Moenchenstein Bridge when it was recently strengthened by Probst, Wolf & Chappuis. Had that been done the disaster, in my judgment, would not have happened in the manner it did.

GUSTAV LINDENTHAL.

Aug. 1, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I read with interest your analysis of the Moenchenstein bridge failure, and from a casual examination the drawings have thought that if this bridge were approached from a curve, at a fair speed, the failure might occur in the upper sway system. No knee or portal bracing is indicated, and the upper lateral struts connect to a flimsy ⅝-in. web, without bottom stiffness except at alternate panels. The struts themselves have 1⅛ in. × ¼ in. lattice, and ¼ in. angles.

A failure from this cause, however, would probably throw the bridge to one side, instead of across the line of track as indicated in Fig. 5—unless the portals should chance to collapse in opposite directions at either end simultaneously; 13,000 lbs. per sq. in., at moderate speed, could not cause fracture of itself.

HENRY B. SEAMAN.

Who is to Blame for the Existence of 'So-Called Engineers."

NEW YORK, Aug. 1, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The remarks of your correspondent concerning "So-called Engineers" deserve careful consideration, but the remedy suggested will not solve the problem, as you have very clearly shown.

The control of enterprises frequently presents opportunities for self-aggrandizement, of which dishonest or disreputable officers sometimes avail themselves at the expense and without the knowledge of the unsuspecting stockholders.

Ostensible or "dummy" contractors, rebates on purchases, bonuses for trade, deposits of capital in favored institutions, disreputable hypothecation of securities, outrageous claims for rock or other measurements, piratical charge for so-called "extra" work, non-observance of contract by ostensible contractor or the distorted interpretation of it in his favor, unnecessary fees for favored counsel, indirect and veiled brow-beating or harassing the engineer into compliance with schemes of plunder are some of the influences that control the selection of subordinates in some enterprises; and in the case of engineering work, the applicant's or incumbent's technical professional or natural qualifications for the work are more likely to be subordinated to his pliancy and adaptability to schemes involved. So that in a case of this kind your correspondent's remedy would not apply.

After all has been said, who is to blame? The "so-called Engineer" (with whom, perhaps, the problem of personal "ways and means" may be an urgent and dominating one), or the so-called "economical" but in reality highly extravagant and corrupt but "enterprising" financier, who makes a fortune, by wrecking the enterprise, or leaving it severely crippled, and who deems it money wasted to employ a competent engineer and his necessary assistants?

From the control of "construction" a fortune may be corruptly and dishonestly amassed, though the future wreck of the enterprise follow.

It is more economical also to employ competent or aspiring natural talent than to deal with the incompetent. True economy consists in judicious, not meager or inadequate expenditures. A so-called "economical" financier may in fact be a very expensive one.

In conclusion, if the mask were torn away from the financial, legal, political, legislative and press guards, behind which corruption is intrenched, and if stockholders would investigate the character and antecedents of parties promoting or controlling an enterprise, it might be better for engineers. TYRO.

The Government Timber Tests.*

BY PROF. J. B. JOHNSON.

The Division of Forestry of the United States Department of Agriculture has commenced a series of examinations and tests of American timbers, which far exceeds in magnitude and in scientific thoroughness anything ever before undertaken in this direction. There are three departments of the work.

I. THE SELECTION OF THE TIMBER.

The trees to be examined and tested are first selected by a competent botanist and forester from five or more localities, four large trees of a given species from each place, these sites differing from each other as much as possible in climate and soil conditions. These trees are cut up into logs from 6 to 18 ft. in length, with intervening disks 8 in. long. A complete record is kept of the botanical name, conditions of growth, time of cutting, age of tree, size, height, etc., and the north and south sides of each log and disk are marked on them, together with the number of the tree and of the log. The logs are shipped to St. Louis and the disks are sent to Ann Arbor, Mich. Disks are also cut from younger trees and sent to Ann Arbor.

II.—THE PHYSICAL TESTS.

The physical tests are carried out at the Washington University Testing Laboratory, St. Louis, under the direction of the writer. The logs are first sawed into appropriate sizes at an ordinary sawmill. Each log is marked off on its end by a stencil plate, in such a way as to obtain a series of 4 in. × 4 in. sticks in a north and south zone, and as large a stick alongside as the log will allow, up to 8 in. × 16 in. Each stick is marked with a die with the number of the tree, the number of the log in that tree and the number of the stick in the log, the numbers being on the lower end of the log and reading upright when the north side is upward. In this way each stick carries a legend, which cannot be effaced, which fully identifies it. A series of stamps, corresponding to the stencils, is used to show in the note book the way in which the log was cut and marked.

After sawing, the sticks are carefully stacked under shelter to await the tests. In the course of from one to three months after sawing one end (half) of each 4 in. × 4 in. stick is tested, and also some of the large sticks. The regular tests are as follows:

1. *The Cross-Bending or Beam Test.*—In this the load is always put on at the same rate, so as to produce an increase in the deflection of ⅛-in. per minute, and continued uniformly up to rupture. The simultaneous loads and deflections are read off about 8 or 10 times during the test, the scale beam always being kept balanced and the deflection read off by means of a micrometer screw on the small beams, and from a thread over a paper scale on the large beams. The 4 in. × 4 in. sticks are tested in lengths of 60 ins. between knife edges, all bearing-surfaces being protected by iron plates. The machine used was specially designed for this kind of work, and was described in ENGINEERING NEWS of Sept. 14, 1889.

The large beams are broken on a machine of an original design consisting of a hydraulic cylinder, plunger, screws and crosshead, made by Riehlé Bros., and similar to these parts used in their 100,000-lb. testing machines. The base or beam part of the machine consists of two long leaf yellow pine sticks, 6 ins. × 20 ins. × 24 ft. long, both being clear, straight-grained wood. Between these there is a steel flitch plate ⅝ in. × 18 in. × 20 ft. long, all bolted together through their neutral axes.

The weighing is done in a standard 100,000 lb. Riehlé machine near by, both being connected up with the same pump, and the weighing machine being blocked. The plungers of the two machines are of the same size, and therefore, except for the difference in the frictional resistances of their plunger packings, they should show the same loads for the same unit pressure in the pump. They have the same kind of leather cup packing, and when tested by nests of calibrating springs they show equal loads for equal deflections of springs. These calibrating springs were first tested on the Emery machine at the Watertown Arsenal, and hence both these machines are now standardized with that one. Since this large beam machine will place a load of 100,000 lbs. in a beam 24 ft. long, there has probably never been a wooden beam or a rolled iron or steel beam which could not be broken on this machine if taken in a length from 20 to 24 ft. This is also the only beam machine of large capacity with which the writer is acquainted. There are following nuts placed on the power screws, by means of which any given deflection can be held, and in this way time tests can be made on large beams.

From the plotted results, loads and deflections, the modulus of elasticity and the total resilience of the timber up to the point of maximum loading in inch pounds per cubic inch of timber are computed in addition to the strength.

2. *The Percentage of Moisture.*—After breaking the beam it is next bored through 18 ins. from each end, and one-third the width of the stick from one side, and the borings used for determining the percentage of moisture. Prof. BAUSCHINGER has shown that when the moisture in a stick falls below 20%, and especially when below 15%, the strength increases very rapidly as the moisture diminishes.

3. *Specific Gravity and Width of Annual Rings.*—The ends of the broken beam are now cut off, and used for making the other tests named below. One of these is weighed and measured, and the specific gravity determined. The number of annual rings is also counted in a radial direction across the stick and the average number per inch is recorded.

4. *Crushing Endwise.*—From each 4 × 4 ins. stick there is cut a section 8 ins. long and from each

large beam there is cut a column 40 ins. long and 4 ins. × 4 ins. in cross-section, and these are tested in compression endwise until the fibres are crushed down and the maximum load passed.

5. *Crushing Across the Grain.*—From each beam there is taken a section and crushed across the grain on an area 4 ins. × 4 ins. The maximum load is found to occur when the compression is about 3% of the height, and hence this amount of distortion is taken as the standard and the compression load found at this limit, which is also considered a reasonable limit in practice.

6th. *Tensile Tests.*—The tensile strength is found by taking a piece 1½ ins. × 2½ ins. × 15 ins. long, and cutting it down on circular curves to ⅝ ins. × 2½ ins. at the center and then pulling it on the 100,000 lb. Riehlé machine. It is held between the ordinary flat wedge-shaped grips. It is very difficult to break timber in tension, but after trying various shapes and methods of holding, the above was found most simple and entirely satisfactory.

7. *Shearing Tests.*—The shearing strength is found by pulling out the ends of slotted holes. A piece 2½ ins. square is slotted 1 in. from each end, with a hole ⅝ in. × 1 in. Steel pins are inserted in these and pulled by means of suitable stirrups. The two holes are cut at right angles to each other and both are pulled out, thus getting the shearing strength both ways with reference to the direction of the annual rings. The stick is kept from spreading, or splitting out, by means of hand clamps which are put on outside the slotted holes and screwed up to a bearing before the test begins, the initial pressure being only a few pounds.

In all the above tests the direction of the rings is sketched in and the records show also its exact position in the log, and in the tree so that all known pertinent facts are recorded. It is only in this way that the laws governing the strength of timber can be found. The reserved sticks will be tested some two years or more later after seasoning, which will be under shelter.

There will probably be as many as 2,000 tests made on each of the more important species of timber, and when these are properly collected and discussed it is thought that little will remain undiscovered in regard to the conditions governing the strength of sound timber of all the common varieties. The work has begun with the Southern yellow pines and oaks six carloads of logs having been received and sawed to date. Since one large stick is cut from each log, and at least two small ones, the relative unit strength of large and small timbers will be determined. The effects of knots, windshakes, seasoning cracks, etc., are also sure to be determined.

TESTS OF OLD TIMBERS.

It is often very desirable to know the strength of old bridge timbers, which, though apparently sound, are more or less cracked along their neutral axes and have been in service many years. If railroad and bridge engineers choose to send in such timbers full size, just as they have been used in the structure, they will be tested promptly and at a very small cost. A few tests of this kind would go a long way toward educating the judgment of a chief or of an inspecting engineer who may be charged with the responsibility of deciding when to replace an old structure with a new one.

III.—THE MICROSCOPIC AND STRUCTURAL EXAMINATIONS.

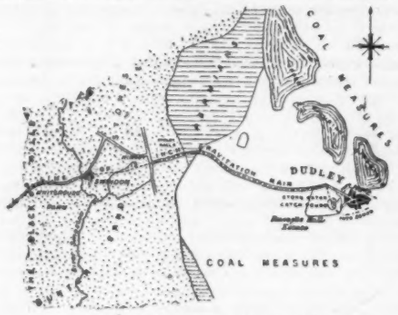
The specimen disks sent to Ann Arbor, Mich., are examined and studied by competent botanists of the University of Michigan, and photographs taken of the structural formation. This article is, however, for the information of engineers and architects rather than of botanists, and hence is mostly taken up with a description of the physical tests. This work will run for many years, if sufficiently supported by public opinion, on which all state work really rests. If it is continued in the same scale of thoroughness with which it is begun, it is impossible to overestimate its value, both to timber users and to timber growers, for one of the ultimate purposes is to learn the conditions most favorable to the profitable growth of the more valuable kinds of timber. Neither are the results of these studies of most immediate use to engineers and architects, but the carriage, wagon and implement makers, car builders, furniture manufacturers and the public generally are equally interested, since it is only the needs of the public which all these are trying to serve.

The Sewage-Disposal Works of Dudley, England.

A paper was lately read before the Institute of Civil Engineers by Mr. EDWARD DIMMACK MARTEN, Assoc. Mem., describing the sewerage and sewage-disposal works of the borough of Dudley, in South Staffordshire, England. This region is underlaid with coal, and ordinary sewerage was attended with great cost owing to the precautions necessary to be taken to prevent the filtration of water to the workings beneath.

Dudley has a population of 46,000; 30,000 in the town itself, and the remainder in scattered mining villages lying within the borough limits. The town is on a ridge ranging from 880 to 660 ft. above sea-level, and the districts to be drained lie on each side of this hill, extending as far down as 500 ft. above sea level. The plan finally adopted for draining this area was as follows:

The town was entirely resewered upon the separate system, with gradients in most cases so steep as to practically require no artificial flushing. For the same cause a few ventilators carried up the sides of houses in the higher part of the town keep the system pure and wholesome. The branch sewers are all stoneware, with joints made with tarred yarn and cement. Manholes are put in at every change in line or gradient. Only one case of stoppage has occurred since 1884, when the system was completed, and this was due to a butcher discharging hot fat into the sewer. The old drains have been generally disconnected, and are now used for storm water only.



Sewage Disposal at Dudley, England.

The sewage thus collected gravitates to intercepting sewers placed along each side of the ridge described. These sewers, whose flattest gradient is 5 ft. per mile, converge at a point near the west side of the town, the northern sewer being in a tunnel for the last half-mile. This tunnel passed through an upheaval of the upper Silurian limestone, and, while no trouble was encountered in driving them, the sewers themselves had to be laid in a thick bed of puddled clay to prevent leakage into the coal workings beneath.

At the point of meeting, the sewage is first sent through rough strainers formed of broken blast-furnace slag, and then passes into a small storm-water catchpond of 2,500,000 galls. capacity. The level of the water line in this pond is 544 ft. above Ordnance Datum, and there is a fall of 344 ft. to the river Smestow, 4½ miles west of this point. West of the river the country rises again to the summit of the Black Hills, which is 426 ft. above Datum, with a gentle fall again westward. The sewage is taken from the catchpond to the Black Hills and across the river Smestow by a 13-in. cast-iron main, acting as an inverted siphon, and 5½ miles long. It is finally delivered on a farm belonging to the Earl of Dudley.

The average fall in the 5½ miles of 13-in. main is 21½ ft. per mile, and the pipe follows all the irregularities of the surface, with blow-outs at the low points and air valves at the summits. The steepest gradients range from 1 in 10 to 1 in 21, and the total rise of 210 ft. to the irrigation farm is made in ¾ mile. To prevent the air valves from choking with sewage a separate connecting pipe was put in between the bottom of the ball seat and the main air-valve branch.

Throughout the last 3 miles the sewer lies solely on the property of the Earl of Dudley, and at convenient intervals laterals lead to circular brick tanks placed on elevated portions of the estate. On each of these a sluice cock is fixed so that sewage may be run into the tank when required. To prevent its discharging high in the air, under the pressure in the main, a wrought-iron shield, or spreader, is fixed over the opening in the bottom of the tank. The ramification of pipes from these receiving tanks covers an area of between 5,000 and 6,000 acres.

But by far the larger part of the present sewage is utilized on the comparatively small area at the terminus of the system, about 722 acres. The soil here is in the conglomerate area, and is poor and sandy, naturally. Prior to the construction of these works these lands were only noted for their sterility. But they have now improved to such an extent that the Earl of Dudley wants more of the sewage, and is threatening legal proceedings against the Corporation for an alleged neglect to compel householders to connect with the new system.

The bargain made was perhaps unique in the history of sewage disposal. The Earl takes the sewage from the Corporation without paying for it, or receiving any payment for this service. He relieves the Corporation, by an ample indemnity, of all further responsibility in connection therewith, and this agreement is ratified by a special act of Parliament. The bargain has been satisfactory to both parties, very unlike the usual experience.

As to the effluent, the soil absorbs it all, and it is impossible to detect, either in the river Smestow and the neighboring brooks, a trace of the proximity of sewage farming. The district is sparsely inhabited, but it has never been suggested that the few local wells are contaminated. The sewage is applied by the intermittent system, and sparingly. The only maintenance expenses are the cleaning out of the slag strainers once a week and the opening and oiling of the air valves once in a month.

The total cost of the works, including the town and intercepting sewers, the catchpond and the 5½ miles of 13-in. main, was $220,000. But the real estate required at the catchpond made the total cost about $275,000. The cost of the 13-in. main, with the necessary air valves but exclusive of the lateral connections, was $1.30 per lineal foot, laid complete. No right of way was paid for. The storm-water catchpond, with the necessary iron and brickwork, cost $3.87 per 1,000 galls. capacity, and, including a high iron fence afterward found necessary, $4.30 per 1,000 galls. capacity.

The Export Trade of the United States.

The accompanying table is compiled from the official statistics of the Treasury Department just issued, and shows some very interesting facts concerning national products sent abroad. The South may take just pride in the fact that the cotton produced from its fields and exported was worth more than twice as much as all the breadstuffs exported. Baltimore's rank as a shipping point is seen to be higher than is generally supposed; but the fall in the shipments of breadstuffs from that point was very great in the past year. The port made a large gain, however, in its shipments of mineral oils,

STATISTICS OF EXPORTS FROM PRINCIPAL CUSTOMS DISTRICTS FOR TWO YEARS, ENDING JUNE 30, 1890, AND JUNE 30, 1891.

(Figures give total value in thousands of dollars.)

Goods.	New York.		Boston.		Philadelphia.		Baltimore.		New Orleans.		Other custom districts.		Total.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
Breadstuffs.	48,613	39,022	10,791	9,942	11 897	6,002	31,003	18,736	9,046	4,125	39,380	45,330	140,690	123,156
*Provisions.	36,325	33,458	14,680	15,030	2,.05	2,208	6 971	6,060	111	147	2,931	2,991	63,223	59,894
Mineral oils.	37 557	37,345	4.270	3,042	11,076	11,655	11,994	15,748	....	....	1,064	1,152	50,855	51,313
†Cotton	....	....	....	....	....	....	....	....	....	....	....	....	243,734	283,567
Total.....	122,495	109,825	29,741	28,014	25,178	19,865	49,968	40,544	9.117	4,272	43,375	49,473	508,502	517,930

* Includes beef, hog and dairy products for *six months* ending June 30. † For *ten months* ending June 30.

which helped to offset the loss. The Pacific ports, included under the head of "Other Customs Districts," were the only ones which made a gain in the amount of breadstuffs exported, the value of breadstuffs shipped from them being $35,289,039 in 1891 against only $28,674,311 in 1889. This was doubtless due in some part to the improvement in Californai agriculture by irrigation, and the settlement of the wheat growing regions on the upper Columbia river, as well as to the excellent crops.

Laying Submerged Water Mains.

Prof. OLIN H. LANDRETH, of the Vanderbilt University, sends us the following description of laying a submerged water main. He says: In view of the interest now being taken in the matter of laying submerged water pipe as indicated by accounts of one or two pieces of work of this character which have recently appeared in engineering journals, it may be of interest to present here an account of an undertaking of this kind which fell under his direction about a year ago.

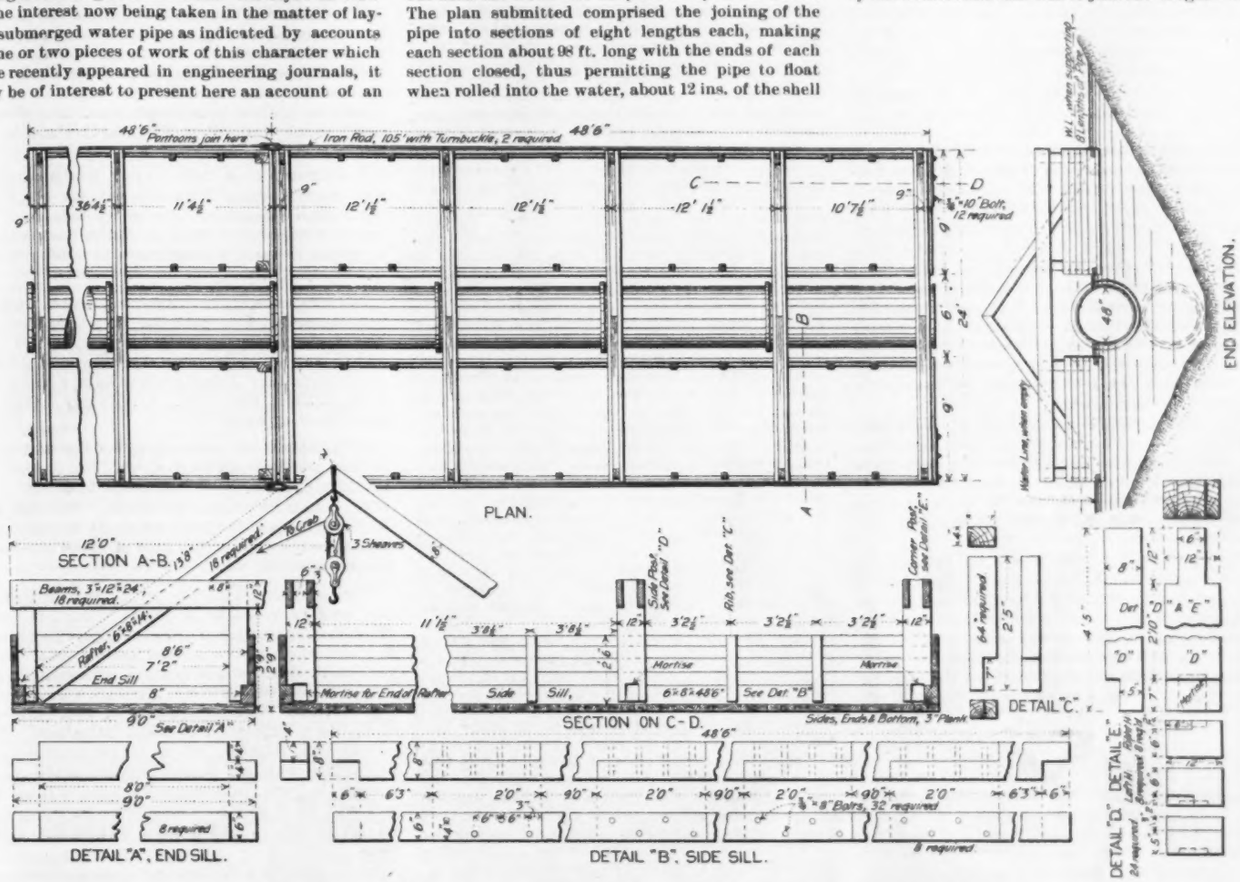
The failure of the system of submerged filter galleries under the island in the Cumberland River opposite the Nashville pumping station necessitated the return to the plan originally recommended, of taking the supply of water for the Nashville water-works from a masonry intake crib to be located in a deep pool in the river some distance above the pumping station, to which the supply was to be led by a submerged supply main following the bed of the river.

The contract for the construction of the masonry intake tower was awarded to Messrs. Whitsett & Adams, in May, 1890, and at the same time the contract for laying the supp'y main was awarded to Messrs. Philbin & Jackson.

The supply main is composed of ordinary hub-and-spigot cast-iron water pipe forty-eight (48) inches in diameter, weighing about 8,500 lbs. per length of 12 ft., without lugs for drawing up. The main from intake to wet well, at the pumping station, is about 1,750 ft. in length, and lies about 10 ft. below low-water line and about 65 ft. below extreme high-water line. After leaving the intake tower the line passes through the open water and on rock bottom for 200 or 300 ft., then passes obliquely through a Government spur dam composed of "one-man rock" thrown loosely into place, then passes through about 300 ft. of open water on solid-rock bottom, then enters the gravel of this island, through which it passes in a trench dredged for it for about 1,000 ft., to the pumping station. At about 600 ft. from each end manholes were required to be constructed reaching above low water.

The specifications of the Water Department required the pipe to be laid "with lead joints and water-tight under 30 lbs. pressure either way," but left the contractors to follow their own plan in laying. In July, 1890, Professor LANDRETH was consulted by the contractors and asked to submit a plan for laying the main, and in accordance therewith the following plan was submitted and substantially carried out until the work was suspended by high water. The plan submitted comprised the joining of the pipe into sections of eight lengths each, making each section about 98 ft. long with the ends of each section closed, thus permitting the pipe to float when rolled into the water, about 12 ins. of the shell projecting above the surface of the water. In this condition the sections were towed into the clear space between 2 pontoons, each 100 ft. long, with 6 ft. of clear waterway between them, the pontoons being framed together by trusses overhead, with blocks and falls and a crab over each 12-ft. length of pipe. With a pipe thus floating between the pontoons, slings were passed around each of the 8 pipes and attached to the falls, which were then drawn taut. A sufficient amount of water to sink the pipe was then admitted through plugs in the ends of the long section and the falls slacked off slowly, so as to allow the section to sink. When the section was fully brought into position in the trench as to grade alinement (and as to rotation for the sections carrying the manhole "tees"), water was admitted to fill the pipe and the bulkheads from the ends removed, the section being left a foot or so away from the previously laid section, in order to permit the removal of the bulkhead. The falls were then strained up, the pipe lifted bodily off the bottom a few inches, and the pontoons warped forward so as to bring the nozzle of the new section into the hub of that previously laid. These joints between different sections were then made with cold lead-hoops previously hammered into form and placed into position and caulked by divers who were rendered necessary to insure that the bottom of the trench should be brought and kept in the proper form for the pipe, the strong current in some portions washing the gravel into the trench before the pipe could be laid and bedded.

Two alternate plans for making up the sections and floating them were submitted; the first by laying and joining the several lengths of each section in a floating caisson so loaded as to be sunk out from under the section of the pipe a few inches when the latter should have its ends closed ready for floating, and then towed out through a water tight gate in one end which could be closed after the pipe was taken out and the caisson pumped dry again. The other plan, which, though simpler, ran the risk of a rise in the river, was the one adopted by the contractors and was to join the lengths into sections on skids on the island and roll them down inclined skids or ways into the water. About one-half the entire line of 1,750 ft. has now been successfully laid by the above method, and will be completed as soon as the river falls to or near its low stage. Had it been important to do so, the work could have been carried on and completed during high water, but as the work of laying the masonry for the intake tower has not yet been commenced there was no reason for haste. The occurrence of rock throughout the whole length of line rendered the methods of lowering the pipe by piling or by coffer dams out of the question, and, if the rock had not excluded them, the certainty of frequent changes in the height of river would have done so.



METHOD OF LAYING SUPPLY MAIN UNDER WATER; NASHVILLE WATER-WORKS.

The trench for the pipe through the island and through the rock dam is being opened by a dipper dredge, and the solid rock in the bottom of trench is taken out by blastholes ranged along both sides of the trench and fired simultaneously. The holes are drilled by a steam drill with a long bit set low down on a raft. Dynamite, with water tamping, is used in blasting. The trenchwork comprises the following approximate quantities:

Gravel excavation	26,000 cu. yds.
Solid rock excavation in trench	500 "
Loose rock excavation and refilling in dam	700 "

The contract price for the work of laying the line

was $18,300. In the actual construction a truss of somewhat different type was used to connect the pontoons, and old flatboats were substituted for new pontoons by some additional work put upon them.

A Runaway on a Steep Grade.

The Colorado Midland Ry. has been rather unfortunate of late in the matter of train accidents. Closely following the scalding of 9 or 10 passengers at Aspen Junction, July 12, came a runaway freight train on the night of July 15, which seems to have occurred notwithstanding great precautions to insure safety. The reports of this latter acident, as published in Associated Press dispatches all over the country, ascribed it to that convenient scapegoat, failure of the air brakes. The exact facts of the case are difficult to determine on account of the killing of the engineer and fireman and the almost total destruction of the train; but the evidence points to carelessness on the part of the engineer as the chief, and perhaps the only, cause of the disaster.

The grade on which this accident occurred extends from Cascade Cañon east to Manitou, 6 miles, falling 4%, or 211 ft. per mile. In this distance are 8 tunnels and many 16° curves. To handle trains with safety when running down this grade the officers of the road have established exceedingly strict rules for the care of brakes, maintenance of trains, etc., and have also, as an extra precautionary measure, built a safety "switch-back" part way down the grade, by which in case a train becomes out of control it is diverted from the main line and runs up a gradually increasing grade. A switchman is constantly stationed here and his instructions are to keep the switch set for the side track.

When a down train is within 800 ft. of the switch, if the train is under control, the engineer blows one long blast, one short blast and one long blast upon the whistle. The switchman then turns the switch to the main line and signals to the train to come ahead, which signal the engineer answers by two short blasts.

But of still greater interest are the precautions taken to insure that the brakes are all right before starting down the grade. All freight trains stop at Cascade Cañon, and before starting down the grade the conductor, car inspector and engineer have each to sign the following certificate. These are numbered consecutively and are forwarded daily by the station agent at Cascade to the superintendent's office:

No.....

COLORADO MIDLAND RAILWAY CO.

FREIGHT TRAIN INSPECTION CERTIFICATE.

CASCADE CANON.....189 .

Train No..... Engine No.....Time..... M.

I hereby certify that I have made a careful examiuation of the above train, and find it to be in good and safe condition to proceed to Colorado City; the air is working properly, and the hand brakes on all the cars are in good order.

No of cars upon which air is working properly, ———

No. of cars without air brakes..... ———

Total..... ———

(Signed).....*Conductor.*

(Signed).....*Inspector.*

I hereby certify that I have read the above, and to the best of my knowleoge the Conductor's and Inspector's statements are correct; and I have a sufficient pressure of air to enable me to properly protect the train from Cascade to Colorado City.

(Signed).....*Engineer.*

Conductors and engineers will strictly observe the following rules in operating freight trains from Cascade Cañon to Colorado City:

1. No train must exceed 15 loads. Two empty cars to count as 1 load; but no train to contain over 20 cars.

2. Not more than 4 non-air cars to be contained in any train; and such cars must have the hand brakes in good order.

3. All cars upon which the air is not working properly must be counted as non-air cars. When it is found that the hand brakes are defective, either on air or non-air cars, and will not assist in holding the train, and the train crew or inspector cannot repair them, such cars must be set out at Cascade.

4. Conductors will ride on top of cars from Cascade Depot to Manitou Iron Springs.
Brakemen will remain on top of cars from Cascade Depot to Colorado City.

5. The gage must register a pressure of 80 lbs. of air before leaving Cascade.

6. All brakes on non-air cars must be set by hand at once on trains starting from Cascade, and all hand brakes on air and non-air cars applied before passing over the Hotel Crossing, just before reaching the 4% grade.

7. Conductors and engineers are again reminded that in every case of doubt they must take the Safe Side.

W. J. LAWRENCE, Superintendent.

With these precautions, which there is every reason to believe are rigidly enforced, it would certainly seem that trains should be operated over this grade with entire safety; and the runaway which occurred on July 15 seems clearly due to the neglect of the trainmen. The circumstances of the accident are detailed as follows by an expert who has made a thorough investigation of the affair:

The train consisted of an engine, 13 cars and way car. The engine was a ten-wheeler of Schenectady build, equipped with ordinary Westinghouse brake, except driver brake, which is American pattern and operated by steam. The 13 cars were mostly box, and the remainder coal, and were all loaded. They were Colorado Midland and Atchison, Topeka & Santa Fé cars, were all provided with brakes, and brakes all working. The way car was equipped with air brake, but on account of a leak in train pipe, the brake on this car was not coupled up to the rest of the train. The train had the usual crew. Engineer MOORE had had many years' experience on mountain grades on various roads, and was not a new man on this road. The train came down about 17 miles of 3% grade to Cascade Cañon, and the brakes held unusually well. At this point all trains are inspected to see that the brakes are in good order. The grade at Cascade, between the switches, is 1½% but a few rods east of the switch changes abruptly to 4%. The rules are quite explicit, and require conductor and both brakemen to ride outside on this 4% grade, and not exceed 12½ miles per hour.

The train in question reached Cascade at 11.10 P. M., and had to wait there for two west bound trains till 12.58 A. M. On arriving, the train was inspected by two inspectors, one on each side, and a certificate of the form above was made out and left with the station agent. The train was not switched nor the engine cut off while at Cascade. Just before leaving, the conductor and rear brakeman noticed that the brakes released from the engine to the way car, and shortly before the conductor was on the engine, and noticed about 90 lbs. pressure on the gage. The train left Cascade at 12 58 A. M., and when it entered the grade, the conductor and each brakeman had each about three hand brakes set. The brakeman noticed that the engineer set his air and got their hand brakes tighter. Before reaching the 800-ft. post, the speed had increased to 25 to 30 miles per hour, according to the conductor, and he was greatly surprised to hear MOORE call for the main line. There is no doubt that MOORE did call for it and it was thrown so, but when the switchman gave him the signal to come ahead, MOORE failed to answer it. The switchman was then about to throw the switch back to the safety line, but had not time before the train reached him. The conductor says that MOORE reversed his engine before passing the safety switch. At some point below here the conductor lost sight of the brakemen's lanterns, and concluded they had jumped, and he cut off the way car with a view to his own safety. He stopped the way car and dropped it slowly down until he met the two brakemen walking back considerably demoralized mentally. He let them go back to flag and went down to the wreck, which he found at the upper end of Tunnel No. 8, about 2 miles below the safety switch. The tunnel is on a 16° curve, and the engine had started to tip over to the outside of the curve just as it reached the tunnel, and had come into collision with the solid granite. The first 10 cars were piled up into about 2 car lengths and utterly demolished. One car was in the creek about 100 ft. below, but the last 2 were on the track unhurt, and with air brakes set. The conductor was obliged by smoke to climb around to the east end of tunnel, and going in found the engineer sitting against the side of tunnel, badly scalded. In answer to questions he said he did not know what was the matter, and that the train was a good holding one. MOORE died about 5 hours after. The fireman was buried under the coal in the tank, and his body was not found for 20 hours. MOORE was not in condition to make statements before his death. He is said to have stated that he did not realize that his train was running away until nearly down to where the wreck occurred, but this is uncertain. The Coroner was on the ground and made an investigation, but decided that an inquest was unnecessary, as the rules of the company and the appliances provided were all that were necessary and possible for the safe handling of the trains. The brakemen's statements added nothing to the conductor's. The engines and cars were too badly wrecked to get any information, except the last two, which were uninjured, and in perfect order. I talked with the Car Inspector, and found him to be an experienced man, and apparently very careful and thorough. This man suggests that the brake valve was left on lap while standing there, but this does not agree with the conductor's statement that he saw 90 lbs. on the gage, and does not seem probable in a man of MOORE's experience. The conductor, in his statement, says he believes the wreck due to MOORE's having too great confidence in the brakes and trying to run too fast. This opinion is shared by Mr. HUMPHREY, Master Mechanic, and I think by other officials, and is, I think, the most probable cause.

The facts that the train was 7 hours late, and a report that the engineer had a prejudice against the safety switch, and had declared his intention to take his chances on the main line rather than use it, lend additional support to the theory that the engineer relied too much on his ability to run down the grade at high speed and still keep control of his train.

THE COAL PRODUCTION of West Virginia, Kentucky, Tennessee, Virginia, Georgia and North Carolina amounted to 11,649,266 short tons in 1889, says Census Bulletin No. 94. This output was valued at $10,943,089, and West Virginia produced one-half of this and Kentucky and Tennessee nearly all of the remainder in about equal proportions. Excepting a small supply from West Virginia this coal is all bituminous.

THE RICHMOND & CHESAPEAKE RAILROAD TUNNEL FRANCHISE has been renewed for one year, after a bitter opposition by property owners. This company proposes to build a double-track tunnel extending from the western limits of the city to the Union depot, piercing the business center.

THE SPARROW POINT BESSEMER STEEL WORKS, near Baltimore, Md., were put into operation on Aug. 1. Excepting the St. Louis mill, this is the first production of Bessemer steel south of Mason and Dixon's line. This plant is to have a daily capacity of about 2,000 tons. Mr. HENRY AIKEN is the Consulting Engineer.

A PHOTOGRAPHIC TELESCOPE, for Harvard University, is being made by ALVAN CLARK & SONS, at Cambridge, Mass. It is intended to be at least one of the largest and finest ever made. The aperture will be 24 ins. and the focal length 11 ft. Harvard now has a telescope of this kind of about one-third the power of this one.

THE HIGHEST INHABITED POINT IN THE WORLD was long supposed to be Galena village, in Peru, 15,635 ft. above sea level. Mr. ARTHUR PEARCE, an engineer who has been making meteorlogical observations in the Andes, is credited with finding two mining camps higher still. These are Vicharrayac 15,950 ft, and Maccapata, 16,158 ft. above the sea. Each has a population of about 200 miners. The narrow-gage railroad, now under construction and connecting with the Galena summit of the Oraya railway, in Peru, will reach an elevation of 15,850 ft., and will have on it a tunnel even longer than the Galena tunnel. The new road will be 46½ miles long.

STEEL TROUGH TIES, imported from England, are used on the Bengal-Nagpur Ry., India; and *Indian Engineering* comments on the fact that the forests of Singhboom are being denuded to supply wooden ties for the East Coast Ry., which ties are carried over the Bengal-Nagpur Ry. to their destination.

THE PLATINUM MINES of Avrorinski, in the Ural Mountains, produced between October, 1886, and August, 1887, 30,336 ozs. of platinum, at a cost of $1.72 per ounce, inclusive of all charges. This was sold for $3.84 per ounce. This amount came from 166,023 tons of wash dirt. So says the *Annales des Mines*, vol. XVIII, p. 537. The deposits are 13 to 16 ft. thick and are covered by 80 ft. of dead ground. The dirt is brought up in shafts by windlasses and washed at the mouth of the pit. The average is 87 grains of platinum minerals per ton. But in some places it is 20 to 50 times this amount.

THE TOPOGRAPHY OF BOSTON is being accurately developed by an elaborate system of triangulation founded on the bare lines of coast-survey work. Points are thus established in every section of the city from which the detailed surveys are carried out. The occasion for this work is found in the fact that existing maps of what is now Boston have been compiled from various and conflicting data; they will not "match" when put together. They are only pictorially correct. The work is being done by the survey and street departments. St. Louis, Mo., as a preliminary step to the expenditure of sev-

eral millions for new sewers, etc., is organizing for a similar triangulation of that city. This is a bit of modern engineering practice that would apply well to other cities that have grown out of a group of independent "districts," like Philadelphia and Chicago, for example.

LOCOMOTIVE No. 34, of the Chicago & Alton Ry., has been provided with a dynamo which runs the headlight, lights the whole train and illuminates the engine and train numbers by electricity. This engine is also provided with a smoke-consuming device, and condenses its exhaust steam, somewhat after the manner of a marine engine. The headlight is placed lower than usual, and the dynamo occupies the place of the ordinary headlight. This engine is an experiment, and if it works satisfactorily all the passenger engines are to be equipped in a similar manner.

THE RAVENNA COLLISION has been investigated by a coroner's jury, and the verdict rendered is as follows:

1. To summarize my finding, I hold J. Pendergast, engineer of Train 8, guilty of carelessness in not notifying the conductor of his train that he had work to do on his engine, so that all the crew might have been on the alert for approaching trains

2. I hold Conductor W. H. Young, of Train 82, guilty of gross neglect of duty. First, by registering and leaving Kent in violation of the rules. Second, in not using due care and diligence in controlling the speed of his train when crossing the Cleveland & Pittsburg Railroad crossing at 20 miles an hour, in violation of the rules and law, and especially in not ordering his men to apply brakes at Morgan's Curve to assist the engineer in coming into Ravenna with his train under control.

3. I find Geo. J. Holmes, engineer of Train 82, guilty of neglect of duty in not blowing his whistle at Morgan's Curve, as that would have notified those at Ravenna of his coming, and of carelessness in not having his train under control.

4. I hold Bernard Dyer, watchman at the interlocking station at the Cleveland & Pittsburg crossing, guilty of gross carelessness in not blocking the freight train when he saw danger was imminent and thus have avoided the collision.

5. I hold that certain rules of the New York, Lake Erie & Western Ry. Co. are defective in this: That Rule 87, which permits a fast freight to follow a passenger train at an interval of 5 minutes, is dangerous, and not in accord with sound judgment and public safety.

6. I hold that the company are remiss in duty in not equipping all fast freight trains with air brakes to insure perfect control of heavy trains.

That an emergency danger signal should be situated at every passenger station, and the person having it in charge should be required to display it in full view whenever a passenger train is detained from any cause beyond its usual allotted time, and that no two fast trains should be permitted on the same territory between contiguous stations at the same time. A. M. SHERMAN, *Coroner.*

It is not often that a coroner's finding in a railway accident contains as much sound common sense as is given in the above. The safe movement of trains by telegraphic orders depends on unceasing and intelligent vigilance on the part of all employees concerned. But in the last paragraph of the decision the real remedy for such disasters as that at Ravenna is given in a nutshell. If no two trains are permitted on the same territory between contiguous stations at the same time, then the essential principle of the block system is introduced; and the very numerous and fatal collisions which have occurred during the past few weeks can be prevented by no other method.

ALUMINUM AT 50 CTS. PER POUND, in ton lots, is the drop announced in a press dispatch from Cleveland, O. The Cowles Electric Smelting & Aluminum Co., of Lockport, N. Y., is credited with making this announcement. We trust it is true, for with aluminum at this price it enters upon and practically captures the wide field held by copper, when the difference in bulk is considered.

THE MISSOURI GEOLOGICAL SURVEY is doing a large amount of field work this summer; and coal, iron, zinc and lead deposits in several counties have been investigated. About 160 sq. miles of territory in the southeastern part of the state has been mapped, and the drawing of maps for publication is making good progress.

CELLULOSE is, for the first time in this country, being used as a water-excluding material, in the sides of the new cruisers Nos. 9, 10, now being built at the Columbian Works in Baltimore. Cellulose is made of cocoanut fiber, or meal made from this fiber, and has an enormous swelling capacity when water is admitted to it through a shot-hole, or otherwise.

RAPID TRANSIT PLANS in New York have progressed to the point that Consulting Engineers THEODORE COOPER and JOSEPH M. WILSON and some others are now examining two radically different sets of plans for the Broadway Tunnel line. At least so says a well-backed rumor, and the time of presentation of the plans to the public will depend upon whether the experts will accept one of these plans in its entirety or suggest a combination or changes.

ANOTHER OHIO RIVER BRIDGE was commenced on Aug. 1 about three miles above Evansville, Ind. It is to be built by the Huntington syndicate that recently purchased the Ohio Valley Ry., running between Henderson and Princeton, Ky. At present the trains are transferred across the river at Evansville by boat.

THE NEED FOR BETTER BRAKES ON STREET CARS, to which we have recently referred, is shown by three collisions during the past week at Spokane, Wash., Portland, Ore., and Atlanta, Ga. The first two occurred between electric cars and the third took place on a steam, dummy line.

THE BELT RAILROAD TUNNEL, in Baltimore, is to be pushed by the use of an overhead shield, which is now being made at the South Baltimore Car Works. The shield will be driven forward by hydraulic jacks and its use will reduce the excavation now made necessary by large arch timbers. McCabe Bros., the contractors for the third section of the Belt railway, have commenced work on the bridge over Jones' falls, above North Ave.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Lehigh Valley.—The contract for the last 14 miles of the Geneva & Van Ettenville R. R. has been let; 8 miles to John Shields, Flemington, N. J.; 6 miles to Sayre & McDonald. The grading on the entire line is rapidly approaching completion, and a considerable amount of track will probably be laid this year.

Lackawanna & Montrose.—Smith & Henwood, of Montrose, Pa., the contractors, are rapidly pushing the grading on the extension of this road near Montrose.

Pennsylvania.—Surveys have been completed and work will soon begin on a 1½ mile branch to R. Heckscher & Son's blast furnace, near Morristown, Pa.—The contract for building a 7 mile branch to collieries near Minersville, Pa., has been let. The work will be quite heavy. —The tracklaying on the section of the Trenton branch west of the Schuylkill River has been completed. This completes one track of the cut-off from Morrisville, N. J., to Glenloch, Pa., 52 miles.——There is talk of building an extension of the McKeesport & Bessemer R. R. to the Youghiogheny River.

Quebec Central.—About 1,300 tons of 70-lb. steel rails and 112 tons of angle plates have arrived from England to be used on the improved grade between Tring and Beauce Junction, P. Q. This portion of the line has been greatly improved by reducing the grades and curvature. In the same cargo there were about 480 tons of 60-lb. steel rails to be used on the proposed line from Tring to Megantic.

Adirondack & St. Lawrence.—Tracklaying has been begun on the section between Valleyfield, P. Q., and Malone, N. Y. The grading between Valleyfield and the International boundary has been finished with the exception of a few unimportant cuts.

Beech Creek.—The contract for the extension from Kerrmore, Clearfield Co., to Patton, Cambria Co., it is stated, has been let to a Mr. Miller, of Lock Haven, Pa.

Chicago & West Michigan.—Tracklaying has begun on the line from Traverse City to Charlevoix, Mich.

Middletown & Cincinnati.—About 10 miles of this railway from Middletown to King's Station, O., have been completed, and it is expected to have the remaining 4 miles finished by Oct. 1. Work is now in progress on the stations.

Projects and Surveys.

Bangor & Aroostook.—A third party of engineers has been put at work on the survey of this Maine railway near Houlton, and will survey the line north. The party is in charge of Chas. E. F. Stetson, of Houlton. Two other parties are at work, one from Brownville north toward Houlton and one from North Twin Dam north.

Grayling, Twin Lakes & Northeastern.—A railway company by this name has been chartered in Michigan. Capital stock, $250,000.

Summit R. R. Equipment Co.—This company has been chartered in New Jersey with a capital stock of $1,500,000. Among the incorporators are: F. S. Kimball, of Philadelphia, and C. C. Pomeroy, of New York.

Eastern Central.—The officials of this company are making an inspection of the route of its proposed railway between Bucyrus and Bowerstown, O. E. B. Shiftley is Chief Engineer and M. Deal, of Bucyrus, O., is Vice. President.

SOUTHERN.—Existing Roads.

Lenoir & Linville.—About 1¼ miles of track have been laid and 8 miles of the grading completed on this North Carolina railway. John M. Houck, of Lenoir, N. C., is Superintendent.

Savannah, Americus & Montgomery.—Tracklaying on the Alabama extension of this railway has been completed to the corporate limits of Montgomery. As soon the bridge is completed across the Chattahoochee River the road will be put in operation. The bridge will be finished in a few weeks.

South Bound.—This road is expected to be opened for traffic from Savannah, Ga., to the South Carolina R. R., 90 miles, by Sept. 1. The track has all been laid, with the exception of about 10,000 ft. on the trestle-work.

Middle Georgia & Atlantic.—An official of this road is reported as saying that construction was making good progress on this road and that tracklaying would soon begin. He stated that 110 miles had been graded and were ready for the track, leaving 126 miles yet to be graded. There is probably some mistake about this. As far as we are aware the only grading done to amount to anything has been on the line between Eatonton and Covington, Ga., about 45 miles, a portion of which is in operation. Arthur Pew, of Savannah, Ga., is Chief Engineer.

Bristol, Elizabethtown & North Carolina.—It is stated that tracklaying will begin on this railway between Bristol and Elizabethtown, Tenn., 75 miles.

Carolina Midland.—This company has made an offer to extend its line from Barnwell, S. C., to Augusta, Ga., about 40 miles, on condition that the people along the route subscribe $480,000 of bonds in aid of the enterprise.

South Florida.—T. L. Morton, of Sanford, Fla., Engineer in charge of Construction, writes us that the proposed extension of this railway from Pemberton Ferry, via Floral City, Inverness, Hernando and Dunnellon, to High Springs, Fla., 93 miles, has been located and bids for construction are now being considered. The work will be light; maximum grade 1%. The principal business will be the transportation of phosphates.

Projects and Surveys.

Charleston, Glendenning & Southern.—At a special election recently held in Kanawha Co., W. Va., it was voted to subscribe $100,000 of the bonds of this road. About $75,000 have been raised by private subscription. The road is projected to run from Charleston to Sutton W. Va., about 100 miles. F. W. Abney, of Charleston, W. Va., is President.

Lake Jessup, Indian River & Atlantic.—The location of this Florida railway from Lake Jessup to Coquina, 45 miles, has been completed. J. S. Brown, Oviedo, Fla., is interested.

Richmond & Chesapeake.—The lower branch of the Richmond, Va., Common Council has voted to extend the purchase for the tunnel under Eighth street.

Oxford & Coast Line.—H. C. Herndon, of Oxford, N. C., President, writes us that nothing has been done except to organize a company to build this road. No surveys have been made and no contracts have been let.

Georgia.—Bills have been introduced in the Georgia State Legislature to incorporate the following railroad companies: Savannah & Oconee, Savannah & Duvall, Georgia Mineral, McRae, Ocala & Southwestern, Madison & Eatonton, and Nacoochee Valley.

Dalton & Spring Place.—The charter members of this company, which is applying for a charter, are: P. B. Trammell, H. C. Hamilton, D. Buckofzer, F. T. Reynolds, of Dalton, Ga., and C. C. Davis, of Chattanooga, Tenn.

Thomson & Lincolnton.—This company has been chartered to build a dummy railway in Georgia. Among those interested are: C. H. Ellington, T. S. Scott and others, of Thomson, Ga.

NORTHWEST.—Existing Roads.

Duluth & Winnipeg.—A dispatch states that tracklaying has begun at Grand Rapids, Minn., for a 5-mile extension across the Oak Point Indian Reservation.

Burlington & Missouri River.—A press dispatch says:

Work is progressing rapidly on the B. & M. extension from the Belle Fourche River in the direction of Sheridan and Buffalo, Wyo. The track has been completed about 20 miles beyond the Belle Fourche, and will be pushed as rapidly as possible to the headwaters of Donkey Creek, a distance of about 10 miles from where the construction gang is now. This extension will completed and in operation by August 15. It is announced that no further construction will be done this season, but the road bed is graded and ready for the iron about 50 miles beyond Donkey Creek, to a point about 50 miles east of Buffalo and about 100 miles southeast of Sheridan. The road as surveyed contemplates a junction, at the point to which the grade is now built, with two branches, one to Buffalo and the other to Sheridan. The country between Buffalo and Sheridan is so mountainous that a road could not be built with profit between these points, hence the junction. It is thought that the construction of the line to these points will be pushed as soon as the road is opened to Donkey Creek.

Belleville & St. Louis.—The grading has been completed on this railway from East St. Louis to the Bluffs,

and it is stated that tracklaying will begin at an early date.

Duluth, Red Wing & Southern.—Surveys have been completed for the 6-mile section between Allouez Bay and the Eastern Minnesota Ry.—It is stated the prospects are good for the early construction of a line from the "800" road in Polk Co., Wis., to Balsam Lake, 12 miles. President F. W. Hoyt is reported as saying that the entire line from Superior, Wis., south to Red Wing, Minn., would be completed within a year.—The Superior & Red Wing Bridge Co. has been chartered, with a capital stock of $50,000, to build a bridge across the Mississippi River at Red Wing.

Projects and Surveys.

Rapid City, Missouri River & St. Paul.—The contract for building this railway from Rapid City, S. Dak., to the Cheyenne River, 40 miles, has been let to John Chamberlain.

SOUTHWEST.—Existing Roads.

St. Louis & Hannibal.—John I. Blair has made a proposition to the people of Ralls Co., Mo., to build lines of railway from Perry to New London and from Oakwood Junction to Hannibal, Mo., on condition that the right of way be donated and $5,400 subscribed in aid of the work.

Projects and Surveys.

FortScott, Kansas City & Northern.—Samuel D. Mosher, Fort Scott, Kan., writes us that the surveys for this proposed railway between Fort Scott, Kan., and Kansas City, Mo., about 100 miles, will probably begin about Sept. 1. A. A. Harris, of Fort Scott, Kan., is President. No chief engineer has been appointed yet.

South Texas Construction Co.—Chartered in Texas with a capital stock of $100,000 to construct railways and bridges. Among the incorporators are Wm. Kepper, of Galveston, Tex., and S. A. McClusken, of Denver, Colo.

South Galveston & Gulf Shore.—Chartered in Texas to build a railway from Galveston, Tex., southwest about 20 miles. Among the incorporators are M. F. Mott, J. N. Sawyer, T. B. Gall and others.

ROCKY MT. AND PACIFIC.—Existing Roads.

Great Northern.—One of the contractors for the Pacific extension of this road is reported as saying that construction is making very good progress on this line. The road has been completed to the Marias River, where a delay was caused by the construction of the bridge across that stream. It is expected to have the bridge finished by Aug. 10, and then tracklaying will be rapidly pushed toward Spokane. The route west from Spokane, Wash., has not been made public yet.

Silver City, Pinos Altos & Mongallon.—The surveys, which have been in progress between Silver City and Pinos Altos, N. Mex., over the partly graded roadbed of this company, have been completed.

Columbia Ry. & Navigation Co.—This company has submitted to the people of Portland a proposal for opening the Columbia River to transportation by completing the Portage Ry., which has been begun by the state at The Dalles, and by putting on barges and steamboats on the river. The proposition made is that in consideration of the taking, by citizens of Portland, of $500,000 of the first mortgage bonds of the company, the company will complete within 8 months a first-class standard gage railway on the north bank of the Columbia, connecting the navigable waters on each side of the obstructions at The Dalles and Celilo, and will place on the Columbia and Snake rivers, east of The Dalles, two first-class steamers and a sufficient number of barges to handle all traffic, and also a steamer between The Dalles and the Cascades, and a sufficient number of steamers and barges between the Cascades and Portland. It is also proposed to build a system of narrow-gage feeders to connect with the line. When complete, the system will comprise about 640 miles of narrow-gage railway, and 660 miles of navigable water.

The directors of the company are A. M. Cannon, of Spokane; Paul F. Mohr, of Tacoma; J. R. Allen, of Spokane; C. B. Niblack, of Chicago, and W. Lair, of Seattle.

Northern Pacific.—The *Chehalis Bee* contains the following in regard to the extension from Chehalis to South Bend, Wash.:

The right of way is almost entirely cleared to the timber beyond Mauerman's prairie, 18 miles up the River Chehalis; and some 17 miles of grading, including that on Pe Ell prairie, is completed. The track is laid to the third crossing of the Chehalis river, 8 miles west of Chehalis, where tracklaying stops until the completion of the bridge, which is well under way. Some talk about work being stopped has been created by the discharge of the tiemakers, but this indicates nothing, as enough ties have been made to finish the road to South Bend. Engineer C. F. Funke, who helped locate the line last year, will start soon with a small party to make a few slight changes in the line on Rock Creek and in Willapa Valley. This indicates an intention on the part of the company to push the work rapidly to completion. Everything depends on whether or not the money needed can be raised by the officers of the road. If they get money the force will be increased to 1,000 or 1,500 men, and the cars will be run into South Bend before Christmas; otherwise the present force will continue and complete the line next year.

Projects and Surveys.

Columbia River & Astoria.—Chartered in Oregon to build a railway from Astoria, Ore., to Goble Station, on the Northern Pacific R. R., near Kuluma, Ore.

Paris, Marshall & Sabine Pass.—L. J. Kopke, of Beaumont, Tex., has begun the survey of this railway from Paris to Marshall Tex., 125 miles.

Montgomery & Western.—James Ferguson, of Montgomery City, Mo., President, writes us that 2½ miles of this road are completed and in operation. The road is projected to run from Montgomery City through Columbia, Fayette and Glasgow, a distance of 74 miles. About 28 miles of the right of way have been secured. All work is being done by the company. J. S. McCleary, of Montgomery City, is Chief Engineer.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are reported as probable at San Jose, Cal., address J. W. Hartzell; Peoria, Ill., address the Riverside Ry. Co.; Sioux City, Ia., address the Sioux City Street Ry. Co.; Cincinnati, O., address the Cincinnati & Suburban Electric Street Ry. Co.; Sutter Creek, Cal., address E. C. Voorheis; Oakland, Cal.; Houston, Tex., address the Houston Rapid Transit Co.; North Danville, Va., address M. H. Buntin; Hagerstown, Md., address the Hagerstown Electric Ry. Co.; Raleigh, N. C., address the Capital City Land Co.; Dandridge, Tenn., address the Dandridge, New Market & Indian Cave Ry. Co.; Baldwinsville, N. Y.; Niles, O., address the Trumbull Electric Ry. Co.; Marion, Ind., address the Marion Electric Street Ry. Co.

Whitinsville, Mass.—An electric railway connecting this place with Manchaug, East Douglas, Douglas, Uxbridge and Millville is under discussion. A branch to Mendon is also proposed.

Newtonville, Mass.—It is reported that the Garden City Street Ry. Co. will build a line for storage battery traction between Newtonville and Newton Center.

Lockport, N. Y.—The Lockport Street R. R. Co. has sold its entire plant to the United States Railway Equipment & Construction Co. of New York. Electric machinery will probably be adopted in consequence of the transfer.

Fort Wadsworth, N. Y.—Dr. L. C. d'Homergul, representing a Brooklyn syndicate, has notified the Richmond County Board of Supervisors that the parties he represents have completed arrangements for purchasing the franchise of the Belt Line Street Ry. Co., and are prepared to rebuild the road from this place to the New Brighton & Port Richmond line when permission is granted. The intention of the syndicate is to finally operate a line from Fort Wadsworth to Howland's Hook.

Paterson, N. J.—The Field Engineering Co. has been awarded the contract for reconstructing the Paterson Ry. and introducing the best electric machinery.

Lock Haven, Pa.—The *Electrical Engineer* states that a company is being organized to build an 8-mile line to Mill Hill.

Shreveport, La.—The City Council has, it is said, granted a franchise to the Shreveport Electric & Motive Power Co., chartered by G. H. Bernos, E. J. Bryan, C. L. McMillan. The Shreveport City R. R. Co. has applied for a similar privilege.

Sherman, Tex.—It is reported that the Sherman City Ry. will be extended 3 miles and operated by electricity.

Memphis, Tenn.—The Raleigh Railway projectors have engaged Eugene T. Lynch, of New York, as engineer of their line. Work will be begun as soon as possible, the financial backing coming from B. L. Duke, of W. Duke, Sons & Co.

Columbus, O.—Consent of property owners is being secured for a new line preparatory to asking for a charter from the Board of Public Works and City Council.

Joliet, Ill.—A storage battery line to Lewistown is proposed by Thomas Creevy and others.

Aurora, Ill.—It is reported that Supt. McQuestin, of the Aurora Street Ry., proposes starting a line between this place and Elgin.

Detroit, Mich.—The Logan storage battery car was tested recently with, it is said, considerable success on the Detroit, Grand Haven & Milwaukee Ry.

Kansas City, Kan.—A number of residents of Quindaro and vicinity have forwarded a petition to W. N. Coler & Co., of New York, asking for an extension of the West Side electric line to Quindaro Park.

Haywards, Cal.—F. Chapellet, W. C. Ames, H. B. M. Miller and others have applied to the Alameda Co. Board of Supervisors for a franchise to build an electric or cable railway from this place through Alvarado, Centerville and Irvington to San Jose. A branch will run from Haywoods through Decoto, Niles and Mission San Jose, tapping the main line at Irvington.

Sutter Creek, Cal.—The directors of the Amador Railway & Light Co. have engaged W. E. Marsh to survey the line of their road from Ione, through Sutter Creek, to Jackson.

O'Brien, Wash.—The farmers in the White River Valley recently held a meeting here and approved the plans of a line between Seattle and Tacoma.

Victoria, B. C.—Bids are wanted until Aug. 15 by the National Electric Tramway & Lighting Co. for supplying 200 tons of 38-lb. girder rails, with fish-plates, bolts, nuts and spikes to match; 300 tons of 40-lb. T-rails with fittings; spikes to be ½ × 4½ ins.

Horse Railways.—New lines or extensions are reported as probable at Madison, Wis., Richmond, Va. Address the Richmond & Manchester Street Ry. Co.

Corpus Christi, Tex.—The Gussett Street Ry. Co. will, it is said, commence work at once on its line.

Anacortes, Wash.—A franchise has been granted H. E. Perrin, C. C. Parkman and E. F. Bogart for a line of railways to be operated at first by horses, to be replaced later by electric motors or cables.

Cable Railways.—*New York, N. Y.*—A petition signed by the most prominent merchants on Sixth Ave. has been sent to the Aldermen asking for cable cars on the Sixth Ave. R. R. The company has already signified its desire to put in such a plant. Work on the Broadway and Third Ave. lines is progressing rapidly.

San Francisco, Cal.—The Cliff House & Ferries R. R. will be extended, and a portion of the existing line double-tracked.

Pneumatic Railway.—*Leavenworth, Kan.*—The Pneumatic Street Ry. Co. of Washington, D. C., has made a proposition to the Board of Trade to establish a street railway and power-house to furnish compressed air for motors, the city in return to donate real-estate to the company. The matter is now under discussion.

Compressed Air Motors.—*Toledo, O.*—The Mekarski Compressed Air Street Car Motor Co. has contracted with the Toledo Consolidated Street Ry. Co. for a trial here of its pneumatic cars.

Underground Railway.—*Chicago, Ill.*—According to the New York *Tribune* a four-track subway will be built under Wabash Ave. by the recently incorporated Wabash Ave. Subway Transportation Co., whose incorporators are G. W. Cole, S. Rhodes, J. W. Pease and others. It is understood that electric traction and stations at alternate streets are proposed.

New Companies.—East Side R. R. Co., Elmira, N. Y.; capital stock, $50 000. West Side Ry. Co., Elmira, N. Y.; capital stock, $100,000. Anderson Belt Ry. Co., Anderson, Ind.; capital stock, $30,000; directors, C. P. Garney, J. C. Morgan, W. L. Finch and others. Denison Street & Belt Line Ry. Co., Denison, Tex.; capital stock, $150,000; incorporators, A. H. Coffin, B. J. Derby, Sam. Star, S. W. Roach. Gettysburg Electric Ry. Co., Hummelstown, Pa.; capital stock, $100,000; E. M. Hopper, President. Great Falls Street Ry. Co., Great Falls, Mont.; capital stock, $199,000; incorporators, A. S. Bigelow, C. H. Bissell, C. O. Parsons, of Boston, and others. Boston & Great Falls Electric Light Co., Great Falls, Mont.; capital stock, $150,000; incorporators same as of G. F. St. Ry. Co. Pittsburg Underground Electric Construction Co., Pittsburg, Pa.; capital stock, $300,000; incorporators, C. D. Robbins, D. J. Rex, C. P. Shoemaker. Worcester & Shrewsbury Street Ry. Co. Worcester, Mass., capital stock, $20,000; incorporators, C. S. Turner, J. M. Drennan, G. A. Stevens and others.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Kalamazoo, Mich.*—A project is on foot to build a viaduct over the Michigan Central R. R. tracks at this place. The structure would be about 600 ft. long and 30 ft. wide.

Saginaw, Mich.—The Bridge Committee has presented a report to the City Council recommending the construction of bridges across the Saginaw River at Court St., Center St., Sixth St. and Genesee Ave., the structures to cost about $72,400, $51,000, $47,000 and $24,000 respectively.

Bennings, D. C.—An iron bridge to cost $60,000 is to be built at this point.

Gilmer Co., W. Va.—The County Court has decided to build a steel bridge over Cove Creek near its mouth.

Galveston, Tex.—At a recent meeting of the Commissioners' Court Walter Gresham presented a proposition for the organization of a $300,000 stock company to build and maintain a wagon bridge across Galveston Bay. Plans and specifications of this bridge by J. A. Waddell, engineer, were presented.

Canals.—Capt. J. J. Williams is now making the surveys for the proposed Tennessee and Mississippi River Canal. The proposed canal will extend from the Tennessee River, at the mouth of the Oak River, up that stream about twenty miles to a navigable point, where boating is then good to Jackson, Tenn. From that place an overland canal of some ten miles, running southwest, will connect at Estimaula with the Big Hatchie River, which furnishes an easy waterway to the Mississippi River, flowing into it 30 miles above Memphis.

HIGHWAYS.

Massachusetts.—A new road is proposed from Braytonville and Greylock to North Adams, and the matter is under consideration by the County Commissioners. There will be 3 bridges.

Pennsylvania.—Springfield Township, Delaware Co., has voted in favor of issuing bonds for $80,000 for road improvements. Clifton proposes to issue bonds for $16,000 for macadamizing.

Tennessee.—The Chickamauga & Chattanooga National Military Park Commission will shortly commence the construction of about 50 miles of road in the Military Park and approaches. The office is at the War Department, Washington, D. C.

Texas.—Kaufman Co. has raised $1,000 for improving the country roads. The Commercial Club, Houston, Tex., is agitating for improved roads and bridges in Harris Co.

WATER-WORKS.

NEW ENGLAND.

Lancaster, N. H.—There is talk of establishing a fire precinct and putting in works costing about $50,000, the supply to be from Garland Brook, 5 miles distant.

Whitefield, N. H.—Surveys for the proposed private works are being made with a view of taking water from a brook, about 5 miles distant.

Springfield, Vt.—Regarding the projected reservoir and company Albert Brown has sent the following:

There is talk of a reservoir to be formed by building a dam at the head of Black River, which flows through this town, some 20 miles distant. The object of the proposed reservoir is to store water for a reserve supply. Subscriptions are being solicited, but no officials have been chosen.

Lowell, Mass.—The practicability of securing a new supply from wells driven near the river is being investigated.

South Hadley Falls, Mass.—The Commissioners have been instructed to build a dam on Leaping Well Brook to increase the supply; also to borrow not over $30,000.

Worcester, Mass.—A masonry dam about 175 ft. long is to be built by the Washburn & Moen Co.

Preston, Conn.—Works are talked of.

MIDDLE.

Arcade, N. Y.—The proposed source of water supply is said to be Skim Lake, about 4 miles south of the village, but G. A. Barnes, village clerk, has written: "We do not intend to put in water-works this year."

Carthage, N. Y.—Moffett, Hodgkins & Clarke, Syracuse, have made a proposition to put in works, with a probable supply from Black River, pumped to a reservoir. There is a strong sentiment, however, in favor of works owned by the village.

Newburgh, N. Y.—Bids for $20,000 of water bonds will be received until Aug. 20. Address M. Doyle, Mayor.

New Rochelle, N. Y.—It is reported that land has been bought at Union Corners for an additional large reservoir.

Walton, N. Y.—It is reported that a new reservoir flooding 10 acres will be built.

Montclair, N. J.—The Newark *Advertiser* states that the company will apply for permission to lay a main through Bloomfield township to connect with the 4-ft. steel supply conduit of the East Jersey Water Co., from which the Montclair Water Co. proposes to draw its supply when the conduit is completed.

Carbondale, Pa.—We are informed that the Carbondale Water Co. has been incorporated, with C. E. Spencer, Treasurer; capital, $10,000, of which $1,000 is paid in. Water is now supplied by the Crystal Springs Water Co.

East Franklin, Pa.—The Franklin Water Co. was incorporated Aug. 4. Capital stock, $5,000, of which $5 only has been paid in. Joseph Buffington, Kittaning, is interested.

Lancaster, Pa.—The Special Water Committee has recommended to the councils that the proposed new 15,000,000-gall. reservoir be located on the Shroder-Long tract, and that the contract be awarded Kitch & Gonder, Lancaster, for $80,000.

Thompson, Pa.—The Thompson Borough Water Co. was incorporated July 28 with a capital of $5,000, all paid in. Treasurer, C. E. Gelatt.

Milford, Del.—It is reported that the construction of the proposed works will be started about Aug. 20.

SOUTHERN.

Waynesborough, Va.—The following is from W. W Fishburne, President:

The Street Railway, Light & Water Co. and town jointly propose to let contracts and begin construction within 60 days. The supply will be pumped from springs, by water power, to a stand-pipe. Cost $12,000 to $15,000. Population, 2,000. There will be about 3 miles of 8 to 4-in. pipe and 15 hydrants.

Salem, N. C.—About 5,000 ft. of 10 and 3,900 ft. of 8-in. mains will probably be laid.

Roncoverte, W. Va.—E. M. Nettleton, Covington, Va., informs us that he has just received a franchise for works and will make surveys this month. Probable supply, river, pumping to stand-pipe. Cost, $30,000. Population, 2,000.

Atlanta, Ga.—The West Side Land Co. has been incorporated by J. R. McKeldin, J. E. Carlton and others; capital, $25,000. It is reported that water-works and a sewerage system will be put in.

Perry, Ga.—City works with a supply from artesian wells is talked of.

Brooksville, Fla.—An election will be held Aug. 14 to vote on the issuance of bonds for works.

Plaquemine, La.—It is reported that J. A. Grace is President and David Altemus Secretary of a company organized to build works.

Franklin, Ky.—S. N. Forline, Town Clerk, has sent the following:

The authorities contemplate building works soon. A large creek flows within a mile of the town, and it is proposed to pump from this to a reservoir or stand-pipe. Estimated cost, $25,000. Population, 2,500.

NORTH CENTRAL.

Indianapolis, Ind.—Works are projected by A. H. Nordyke and A. K. Hallowell to supply their property in the northeast part of the city. Supply, Fall Creek. Cost, about $20,000.

Valparaiso, Ind.—A press dispatch states that a local company has been organized to build a second system; capital, $50,000. Supply, Flint Lake, 3 miles north. Works were built in 1886 by the City Water Co., but it is said that citizens are dissatisfied with the water rates.

Buchanan, Mich.—Bonds to the amount of $50,000 have been voted for water power and works. A dam will probably be built across St. Joe River.

Milford, Mich.—It is again reported that works are projected.

Romeo, Mich.—It is reported that $26,000 in bonds has been voted for works. The proposed supply is from artesian wells. B. N. Seamons is Village Clerk.

Berwyn, Ill.—The Berwyn Water, Fuel & Light Co. has been incorporated by W. J. Andrews, C. E. Piper and G. S. Thompson; capital, $25,000. This is a new village near Chicago. It is expected that water will be introduced at once.

Highland Park, Ill.—It is reported that Moffett, Hodgkins & Clarke, Syracuse, N. Y., may build works to supply several villages along the Chicago & Northwestern Ry., near Evanston.

Monticello, Ill.—The Council has voted to build works. A well has been sunk to a depth of 300 ft.

Paw Paw, Ill.—C. F. Preston, Village President, has sent the following:

Bids for works to cost from $8,000 to $10,000 are wanted until Aug. 21. Water will be pumped from a 4½-in. well to a tank at an elevation of 72 ft. A 16-ft. windmill will be used. Population, 1,000.

NORTHWESTERN.

Wall Lake, Ia.—Bonds for works have been voted, and it is reported that the contract has been let.

Hannibal, Mo.—A settling reservoir may be built by the company, construction beginning this fall.

Beeville, Tex.—It is reported that the project for works has been revived.

PACIFIC.

Tacoma, Wash.—A press dispatch states that the Council has repealed the ordinance ordering a special election on Aug. 4 to vote on the issuance of $1,500,000 of bonds to purchase or construct water-works. An ordinance creating a water commission of 11 citizens to inquire into city ownership of the present works was passed.

Dallas, Ore.—The following is from A. V. R. Snyder:

Works estimated to cost about $60,000 will be built by a company to be form d by Charles P. Shore, Palace Hotel, San Francisco. The supply will be by gravity from La Creole Creek. There will be 25 hydrants. Population, 1,800. Construction will be started about Oct. 1.

Bakersfield, Cal.—The company will erect another and larger tank, placing it beneath the old one, on an independent structure.

Berkely, Cal.—It is reported that a new reservoir will be built by the Alameda Water Co.

Tucson, Ariz.—A well will be sunk, and a 10,000-gall. tank erected by the School Trustees.

CANADA.

Pembroke, Ont.—J. A. Fortier informs us that it will be 3 months before the by-law for authorizing the borrowing of $50,000 for works can be voted on.

MEXICO.

Chihuahua.—G. H. Utter, Silver City, N. M., who holds a concession for works at this place, has given us the following:

The Chihuahua City Water Co. has been organized under the laws of New Mexico, with a non-assessable capital stock of $350,000. A 99 years concession, or franchise, exempt from taxation for 25 years, has been granted by the Mexican Government. The supply will be pumped from the Chivasca River, about 2 miles above the center of the city, to a 5,000,000-gall. distributing reservoir about 70 ft. above the pump. There will be two high-duty pumps with a combined capacity of 5,000,000 galls. There will be 12,000 ft. of 16-, 2,000 of 14-, 39,000 of 8-, 10,000 of 6- and 5,000 ft. of 4-in. mains; also about 75,000 lbs. of specials and 12 hydrants. The material for the pipe has not been decided, but wrought iron or steel is under consideration. Financial arrangements are in progress. Population, 22,000 to 25,000.

ARTESIAN WELLS.

Columbus, Ga.—It is reported that a well has been located by Heerdegen & Schnee, New York, and that bids for sinking it have been let. It is expected that water will be found about 700 ft. below the surface. If successful the water will be used by the water company.

Union Springs, Ala.—A press dispatch states that J. O. Stakeley, Chairman of the Water-Works Committee, has arranged with Morgan Gilmer to make some tests for artesian well water in the city.

Osage, Kan.—A well to run a flouring mill is projected.

Aberdeen, S. Dak.—A company has been organized to sink wells on the farms of the members of the company. Machinery has been ordered.

Kansas City, Mo.—The Midland Hotel Co. proposes to sink a well.

Archer, Tex.—It is reported that a well will be sunk by the citizens.

IRRIGATION.

Lakeland, Fla.—It is reported that an irrigating plant will be constructed by L. J. J. Nieuwencamp.

Great Falls, Mont.—The Sun River Irrigation & Ditch Co., recently incorporated, proposes to build a dam, 12 ft. high and 400 ft. long, across the Sun River at Priest Rapids, and irrigate both sides of the river by means of ditches 12 ft. wide at the bottom and 20 at the top. It is said that two Knowles pumps will be used to force water to a storage reservoir.

Utah.—The Quirrh Water & Land Co. was recently incorporated with a capital stock of $400,000. E. P. Sears is President; J. C. Sloan, Secretary; W. E. Robinson, C. E., General Manager, and Bennett, Bradley & Marshall, Salt Lake City, have served as attorneys. The company proposes to lower the water in Utah Lake, thus reclaiming a large area, and to irrigate land between Utah and Great Salt Lakes. According to the Salt Lake *Herald* the company proposes to pass water for the lower land through the bed of the outlet to lake, and to use water power to raise water about 100 ft., to the plateau above, from which point it will pass to irrigate the higher land. Surveys for about 30 miles of canal have been made.

New Companies.—Sand Arroyo & Triple Lake Canal Co., Arlington, Col.; $10,000. Gardena Water Supply Co., Los Angeles, Cal.; $200,000; C. G. Harrison, A. E. Pomeroy; to furnish water for irrigation and domestic use on the Downey and Hayward tract in the Rancho San Pedro. City Creek Water Co., San Bernardino Co., Cal.; $216,000; Directors: James Fleming, Charles Hidden and others; to furnish water in San Bernardino Co.

SEWERAGE AND MUNICIPAL.

Sewers.—***New Hampshire.***—Dover. It is proposed to spend $10,000 on sewer extensions.

Massachusetts.—West Springfield. The sewer contract has been let to Sackett Bros., at $10,700. There will be 870 ft. of brick sewer 28 × 42 ins., and 570 ft. of 20-in. pipe.—Palmer. Plans for sewerage have been prepared by Mr. Vanvalkenburg. It is proposed to discharge the sewage into the river, but provision is made for sewage disposal by irrigation if necessary.

Rhode Island.—Woonsocket. Reports on a sewerage system have been made by Mr. C. A. Allen, City Engineer of Worcester, Mass., and by Shedd & Sarle, of Worcester.

Connecticut.—Meriden. The Sewer Committee has under consideration the plans prepared by Mr. T. H. McKenzie, of Southington, for an irrigation sewerage system.

New York.—Newton. A drainage system is proposed at a cost of about $26,000.—Holland Patent. A sewer to Beaver Creek is being surveyed by Mr. F. N. Phelps, of Forestport.—Syracuse. Dr. Totman, Health Officer, has made a report to the Board of Health to the effect that the sewerage system is in poor condition.

New Jersey.—Plainfield. The Common Council has awarded a franchise for sewerage to J. M. Low, of Kingston, N. Y.—Bridgeton. A report on a sewerage system has been made by Mr. Rudolph Hering and Mr. Howard Murphy, of Philadelphia, Pa. The plans will be prepared by Prof. C. McMullen, of Princeton, N. J.

Ohio.—Ironton. Mr. Hering has presented his report recommending the separate system, with a combined sewer for the Rachel Creek Valley.—Oberlin. A sewer system is being designed by Dunham & Paine, of New York.

Virginia.—Charlottesville. The City Engineer is making a topographical survey for the purpose of laying out a sewerage system.

Illinois.—Pontiac. The contract for the main brick sewer has been awarded to M. Tschirgi, of Dubuque, at $16,733. It will be 24 x 36 ins. and 7,200 ft. long.

Iowa.—Mason City. The city will advertise for proposals for a sewer 4,500 ft. long, of 8-in. to 14-in. pipe. The plans were prepared by Mr. M. Tschirgi, Jr., of Dubuque, Iowa.

California.—Woodland. A proposition to build a sewerage system for $39,550 has been made by Raymond & Bay, of San Francisco. A contract has been made with Reed & Wilson, of Oakland, to furnish plans and construct the work at a cost not to exceed $40,000.

Washington.—New Whatcom. The report and plans of Mr. J. N. Muller, of St. Paul, Minn., have been accepted by the City Council. He recommends the separate system, discharging into Bellingham Bay, and estimates the cost at $226,000, or about $10,765 per mile.

Streets.—***Massachusetts.***—Brockton. About $50,000 will be expended on street work this year.

Rhode Island.—Pawtucket. Experiments are to be made with the vitrified paving brick manufactured by the New England Steam Brick Co., at Barrington, R. I.

New York.—Dunkirk. Central Ave. is to be paved with vitrified brick manufactured by the Park Fire Clay Co., Beaver Co., Pa. The contract has been awarded to Harold, Dutro & Rickard, of Beaver Falls, Pa., at $80,000.

Ohio.—Oberlin. The town has let a contract for ½ mile of stone slab pavement, of which there are several miles now in use. The slabs are of Berea sandstone, 8 ft. long, 4 to 6 ft. wide and 8 to 10 ins. thick, and are laid so as to give a driveway 8 ft. wide, the rest of the street being unpaved. The soil is stiff clay. The pavement costs 15 cts. per sq. ft. laid. Mr. W. B. Gerrish has made a survey of the streets as they now exist, the records having been destroyed, and has established the street grades.

California.—San Jose. The Santa Cruz Rock Paving Co. has a $60,000 contract for bituminous rock paving.

Bonds.—Eaton, O.; $67,000 for water-works; Isaac Sliver, Village Clerk, Aug. 20.—Watertown, Mass; $100,000 at 4½%, for sewers.—Columbus, O.; several thousand dollars for streets, sewers, viaduct, etc.; J. M. Donne, City Clerk, Aug. 26.

ELECTRICAL.

Electric Light.—New plants or extensions of those already operating are reported as probable at Mayville, N. Y.; Cincinnati, O., address the Newport Light Company; Goshen, Va.; Muncie, Ind.; Kenova, W. Va., address L. F. Peck; Kensee, Ky., address the Main Jellico Mt. Coal Company; Milton, Fla., address J. B. Crossland, of Pensacola; Leslie, Mich.; Aurora, Ill.; Luling, Tex.; Tarkio, Mo.; Wanoo, Neb.; Butler, Mo.; Waynesboro, Pa., address the Electric Light Company; Claremont, N. H.; Villisca, Ia.; Red Oak, Ia.; Eagle Grove, Ia.; Wakefield, Mass.; Ellicott City, Md., address W. L. Nott; Wheeling, W. Va., address N. E. Whittaker.

Plymouth, N. H.—Stock in a local lighting company to the amount of $10,000 has been subscribed. A meeting of the stockholders was recently held and articles of incorporation adopted. Work is to be pushed as rapidly as possible.

Willimantic, Conn.—The Willimantic Gas Co. will erect a new lighting station 100 × 45 ft. on the ground, and 20 ft. high. It will be fitted with one 7-HP. and three 50-HP. Otto engines, a 16 × 36 improved Green engine, and a 150-HP. boiler and four 50-light Ball arc dynamos.

St. George, N. Y.—The plant of the Staten Island Electric Light Co., which was destroyed by fire Aug. 3, will be rebuilt as soon as possible. The old plant had a capacity of 200 arc and 6,000 incandescent lamps.

Syracuse, N. Y.—The Common Council has passed the franchise of the Onondaga Electric Co. over the Mayor's veto.

Schenectady, N. Y.—Bids for street lighting are wanted by the city.

Orange, N. J.—The Essex County Electric Co. will erect a large plant for lighting in this city. The building will be fireproof and contain two 300-HP. Corliss engines, six 100-HP. Ball engines, and 32 dynamos giving a total capacity of 1,440 arc or 16,000 incandescent lamps.

Macon, Ga.—It is reported that the Macon City & Suburban Street Ry. Co. will probably erect a plant costing $35,000.

Kansas City, Mo.—Bids for municipal lighting will be received until Aug. 10. The advertisement calls for 100 or more arcs of 2,000 c. p. to be located by the city officials and burning all night.

Missoula, Mont.—The Missoula Electric Light Co. will increase its plant with machinery for 1,300 more lamps. Bids still received.

New Companies.—Cambridge Electric Light & Power Co., White Creek, Cambridge and Jackson, N. Y.; capital stock, $7,000; Directors, J. B. Rice, J. L. Agan, A. B. McNish and others. Citizens' Electric Light & Power Co., Springfield, Ill.; capital stock, $100,000; incorporators, L. Sparks, J. W. Jefferson, P. H. Day. Edison Electric Illuminating Co., Atlanta, Ga.; capital stock, $10,000; incorporators, J. F. Dickinson, W. H. Rhett, W. H. Inman. Georgia Electric Light Co., Atlanta, Ga.; capital stock, $600,000; incorporators, H. M. Atkinson, H. E. W. Palmer, W. R. Joynes and others. Penn Yan Electric Light & Power Co., Penn Yan, N. Y.; capital stock, $100,000; incorporators, H. O. Stimson, of Boston, H. Russell, of Albany; H. L. Woodruff, of Penn Yan, and others. Van Gestel Lamp Co., Denver, Col.; capital stock, $200,000; incorporators, J. W. Flinthan, M. H. Stearn, N. M. Tabor and others. Kettle Falls Light & Power Co., Kettle Falls, N. Y.; capital stock, $100,000; incorporators, G. H. Smith, A. A. Davis, J. H. Richards and others, all of Rochester.

CONTRACTING.

Paving Blocks.—***Boston, Mass.***—The contract for furnishing 300,000 paving blocks has been awarded to the Rockport Granite Co., at $77.65 per 1,000.

Pawtucket, R. I.—The contract for 185,000 granite paving blocks has been awarded to Garvey Bros., of Providence, R. I., at $65 per 1,000. The blocks will be 8 to 12 ins. long, 3½ to 4½ ins. wide, 7 to 8 ins. deep, 23 blocks to the sq. yd.

Ditch.—***Mount Vernon, Wash.***—The contract for digging a ditch 18 ft. and 10 ft. wide at top and bottom, and 7 ft. deep, through Olympia Marsh, has been awarded to P. Smith at $90 per acre for clearing and 16 cts. per cu. yd. for excavation.

Levees.—The Louisiana State Board of Engineers has awarded contracts as follows: Alexandria levee, Keogh, Moore & Co., 13⅝ cts. per cu. yd.; Beaver Dam levee, C. D. Leeper, 14.75 cts. per cu. yd.

Masonry, Etc.—***Johnstown, Pa.***—The contract for work on the river improvement has been awarded to Evan Jones & Son, of Pittsburg, Pa. Dry river wall, $2.95 per cu. yd., and $3.40 with large stones to be handled by derricks. Excavating and depositing wet and dry material, 44.9 cts. per cu. yd. Excavating and depositing material above water line, haul not exceeding 500 ft., 49 cts. per cu. yd., and 1/10 ct. extra per cu. yd. per 100 ft. extra haul; deposits in water 81 cts. per cu. yd. for same haul, and same extra.

Sewers.—***Terre Haute, Ind.***—Proposals have been received by Mr. Frank H. Cooper for two sections of sewers. The brick sewers are egg-shaped, double-ring, and the pipe sewers are circular. The bidders were as follows: A, Irwin & Maher, Greenville, O.; B, A. Bruner, Indianapolis, Ind.; C, Robertson & Mercer, Terre Haute, Ind. Both contracts were awarded to Robertson & Mercer. The prices of bids are given in the following table:

	Av. cut	A	B	C
	ft.	$	$	$
Brick.				
36 × 54 ins., 587 lin. ft.	17.0	5.50	5.75	5.60
34 × 51 ins., 360.66 "	22.0	5.90	6.50	6.40
30 × 45 ins., 367.20 "	22.5	5.80	6.25	6.00
28 × 42 ins., 352.10 "	21.5	5.75	5.50	5.47
Pipe.				
30-in. 65.00 lin. ft.	16.0	4.45	3.75	3.60
24-in. 415.32 "	18.0	3.40	3.00	3.00
22-in. 363.57 "	18.0	3.25	3.00	2.95
21-in. 1,157.46 "	15.6	2.50	2.25	2.30
18-in. 420.00 "	14.0	2.10	1.75	1.70
12-in. 493.07 "	11.5	1.50	1.15	1.10
6-in. conns to curb line, 102 each	....	22.00	15.00	14.00
17 catch basins, Plan A, each	....	140.00	80.00	70.00
6 " " " B, "	....	130.00	55.00	50.00
8 " " " C, "	....	140.00	80.00	70.00
6 manholes on brick sewers, each	....	100.00	55.00	50.00
6 " pipe " "	....	55.00	50.00	50.00
Total		26,056	20,928	20,273
Brick.				
36 × 54 ins., 775.78 lin. ft.	10.5	3.95	4.00	3.80
34 × 51 ins., 718.50 "	10.6	3.50	4.00	3.80
30 × 45 ins., 364.26 "	17.8	4.75	4.55	4.50
28 × 42 ins., 361.46 "	22.6	5.40	6.00	5.80
Pipe.				
30-in., 65.00 lin. ft	19.0	4.45	5.00	5.00
18-in., 1,003.55 "	18.0	3.50	2.75	2.60
15-in., 1,080.00 "	13.0	1.75	1.50	1.40
12-in., 300.00 "	10.3	1.50	1.00	1.00
6-in. connections to curb line, 85, each	....	22.00	15.00	14.00
14 catch basins, plan A, each	....	140.00	80.00	70.00
6 " " " B, "	....	130.00	60.00	50.00
11 " " " C, "	....	140.00	80.00	70.00
6 manholes on brick sewers, each	....	120.00	55.00	50.00
5 " on pipe " "	....	75.00	50.00	50.00
Total		22,647	19,023	17,950

Brick.—***Washington, D. C.***—The District Commissioners have received the following proposals for paving and sewer brick. The bids were per 1,000. *A*, A. Gleason; *B*, Washington Hydraulic Press Co.; *C*, Washington Brick Machine Co.:

	A.		*B.*		*C.*	
	Pav.	Sew.	Pav.	Sew.	Pav.	Sew.
Washington	$ 9.74	$8.00	$10.50	$8.75	{ $10.93 / 15.97	$7.23 / 8.93
Georgetown	10.00	8.75	.....	.....	{ 9.43 / 11.43	7.73
County	10.00	8.75	.....	.....	{ 11.93 / 13.93	9.23

Pawtucket, R. I.—A contract for 200,000 vitrified paving bricks has been awarded to the New England Brick Co., of Providence, R. I., at $11 per 1,000.

Street Work.—***Indianapolis, Ind.***—Contracts for brick paving have been awarded by the Board of Public Works, the prices being per front foot on each side. The bidders were as follows: *A*, Minnehaha Granite Co.; *B*, Indianapolis Paving Co.; *C*, Fulmer & Seibert; *D*, R. Kennington.

Bidders.	Streets.	Length, ft.	Width, ft.	Area, sq. yds.	Brick.	Curb.	Price.
						Stratified	$
A	College Av.	2,432	40	11,608	Ottawa.	limestone	6.34
"	So. Meridian St.	1,757	18½*	7,691	"	"	6.90
"	"	2,063	16	7,601	"	"	5.70
"	"	1,602	11*	4,105	"	"	4.30
B	College Av.	2,671	36	11,070	Brazil.	"	5.20
"	"	2,620	40	12,100	"	"	6.21
C	So. Delaware St.	2,902	16*	10,321	Ohio Val.	Oolitic.	5.70
D	Pearl St.	885	20	2,005	London.	"	3.00

* On each side of car tracks.

Boston, Mass.—The following proposals have been received for block paving on Dorchester St.: Granite block pavement on gravel, $1.35 to $1.45 per sq. yd.; edgestones, 24 to 31 cts. per lin. ft.; brick sidewalk, 83 to 95 cts. per sq. yd.; flagging crosswalk, $1.35 to $1.60 per sq. yd.

PROPOSALS OPEN.

Sewers.—***Danbury, Conn.***—In Deer Hill Ave. and West St. J. K. Wilkes, City Engineer. Aug. 14.

Springfield, Mo.—Plans and specifications prepared by Nier & Hartford, and to be obtained of C. P. Johnson, City Engineer. G. W. Hackney, City Clerk. Aug. 11.

Street Work.—***Roanoke, Va.***—About 10,600 sq. yds. of brick paving. G. L. Bennett, City Clerk. Aug. 15.

Brooklyn, N. Y.—Grading and cobblestone paving. J. P. Adams, Commissioner of City Works. Aug. 11 and 12.

North Tonawanda, N. Y.—Brick paving on broken stone foundation, with Medina stone curb and gutters. T. E. Warner, Village Clerk. Aug. 17.

Cement.—About 7,000 bbls. of American hydraulic cement at Fort Warren, Mass. Lieut.-Col. S. M. Mansfield, U. S. Engineer Office, Boston, Mass. Aug. 20.

Levees.—Below Helena, Ark.; about 228,000 cu. yds. Capt. S. W. Roessler, U. S. Engineer Office, Memphis, Tenn. Aug. 15.

About 4,600 yds. rip-rap for protecting the Shawneetown, Ill., levee. Lieut.-Col. W. E. Merrill, U. S. Engineer Office, Cincinnati, O. Sept. 1.

Engine and Boilers.—***Buffalo, N. Y.***—Pumping engine of 20,000,000 galls. capacity; 4 cylindrical boilers. Water Commissioners. Aug. 11.

Bridge.—***Washington, D. C.***—Iron highway bridge over the eastern branch of the Potomac River at Benning. The District Commissioners. Aug. 22.

Railway.—Scraper and dump-car work; filling in trestles on Northern Pacific R. R. W. C. Davie, 112 Tenth St., Tacoma, Wash.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Roanoke Machine Works, of Roanoke, Va., have an order for three engines for the Norfolk & Western. The Schenectady Locomotive Works, of Schenectady, N. Y., have delivered four 10-wheel engines to the Southern Pacific; cylinders 18 × 24 ins.; driving wheels, 63 ins. diameter, weight with tender 150,000 lbs. The Richmond Locomotive & Machine Works of Richmond, Va., have made and shipped 5 locomotives during the last 5 months. Four of these were for the Louisville Southern, and 6 more are to follow from the same works. About 30 engines are now under construction.

Cars.—The Wagner Palace Car Co., of Buffalo, N. Y. is building 30 sleeping cars for the New York Central and Lake Shore & Michigan Southern, to run between New York and Chicago. The Roanoke Machine Works, of Roanoke, Va., are building 150 flat cars and 25 cabooses for the Norfolk & Western. The Central Car Repair Mfg. Co. has acquired the works of the East Street Reape Works, at Springfield, O., and will use them as car works.

Car Heating.—The United Railway Car Heating Co., of Boston, has been acquired to operate the Emerson patents. President, H. H. Stevens; Treasurer, C. H. Cole. The system has been tried on the Connecticut River road, and can be worked in connection with the Baker heater.

John Maslin & Son, of Jersey City, N. J., manufacturers of pumps, etc., have opened headquarters in New York at 66 Cortlandt St. They report large sales of duplicate parts. Their steam vacuum pump was described in ENGINEERING NEWS April 4, 1891.

Binder & Seifert, of Chicago, Ill., have the contract for furnishing and erecting all the iron and steel work for the National Brewery, St. Louis, Mo., for $47,000.

Tube Works.—The Duquesne Tube Works Co., of Duquesne, Pa., has increased its capital stock to $150,000, and will manufacture butt-welded as well as lap-welded pipe; President, W. A. Dunslee; Secretary, H. H. Davis; General Manager, W. L. Hurd. The National Tube Works Co. has been reincorporated under the laws of New Jersey, with a capital stock of $11,500,000.

Companies.—Wrought Steel Wheel Co., Trenton, N. J., to manufacture car wheels; President, Wm. P. Shinn, Pittsburg, Pa.; $2,000,000. Ohio Car Wheel & Foundry Co., Toledo, O.; $50,000. Shenango Valley Steel Co., New Castle, Pa.; $300,000.

Metal Market Prices.—***Rails.***—New York: $30.75 to $31; old rails, $21.50 for iron and $17 for steel. Pittsburg: $30; old rails, $23 to $23.50 for iron and $17.50 to $18 for steel. Chicago: $31.50 to $33; old rails, $22.75 to $23.25 for iron and $14 to $16 for steel.

Track Materials.—New York: steel angle bars, 1.75 to 1.8 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.7 to 2.8 cts. Pittsburg: splice bars, 1.75 to 1.85 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.75 cts. with square and 2.85 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.75 to 2.8 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14.50 to $18. Pittsburg: $14.75 to $16.75. Chicago: $14.50 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 55 and 45 per cent. on black and galvanized butt-welded; 65 and 52½ on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—New York: 4.4 to 4.45 cts. Chicago: 4.25 to 4.3 cts. St. Louis: 4.2 to 4.3 cts.

To Tunnel Contractors.

Geo. S. Good & Co., of Lockhaven, Pa., have a contract with the Clearfield Extension of the Beech Creek R. R.

The work is heavy, there being two tunnels in it, and they will sublet some part of it to responsible parties. No letters answered. Office on work at Kerr Mgor, Clearfield Co., Pa. GEO. S. GOOD & CO. 32-2t